AERO DIGEST

INCLUDING
AVIATION ENGINEERING

OCTOBER 1954

military procurement issue

THIS ISSUE $1.00

Convair builds the world's most advanced aircraft through...

Engineering to the Nth power

NAVY'S XFY-1 TAKES OFF AND LANDS ON A DIME

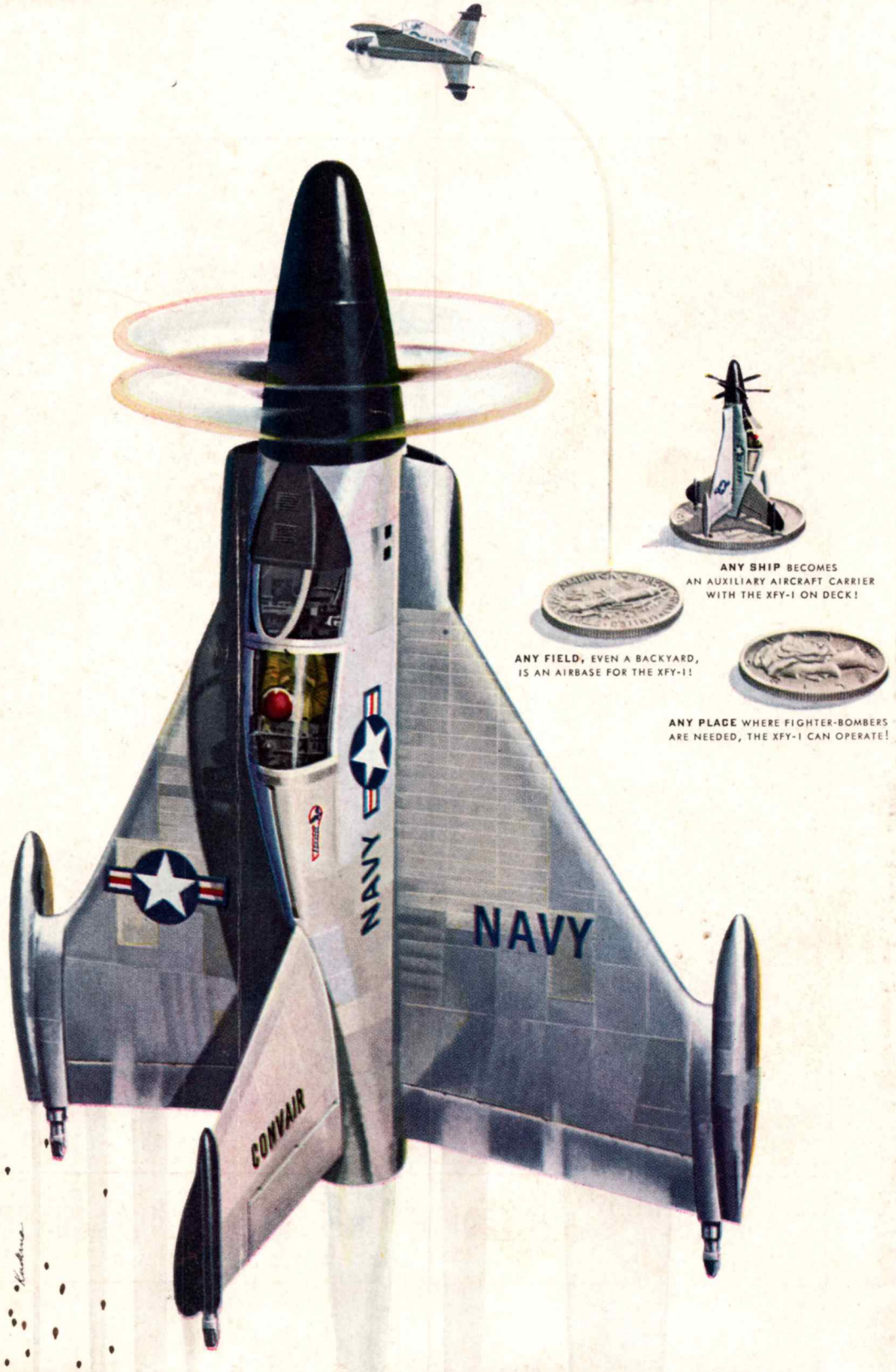
Here's a new kind of aircraft for America's aviation arsenal...the Convair XFY-1, a vertical takeoff, delta wing Navy fighter. Powered by a turbojet engine, it is one of the world's fastest propeller driven planes.

The XFY-1 is as responsive as a hummingbird over a rose bud. It rises nose-up like a guided missile ...flies like a fighter at speeds beyond 500 mph...hovers motionless...darts forward, and sideways...backs down on its tail to a feather-light landing.

This remarkable aeronautical achievement is another result of Convair's engineering for the *maximum* degree of performance... the Nth degree of air power...

Engineering to the Nth power

CONVAIR
A DIVISION OF
GENERAL DYNAMICS CORPORATION



ANY SHIP BECOMES AN AUXILIARY AIRCRAFT CARRIER WITH THE XFY-1 ON DECK!

ANY FIELD, EVEN A BACKYARD, IS AN AIRBASE FOR THE XFY-1!

ANY PLACE WHERE FIGHTER-BOMBERS ARE NEEDED, THE XFY-1 CAN OPERATE!

"Triple Threat"

Chance Vought Aircraft's potent F7U-3 Cutlasses, now entering squadron service with the U. S. Navy, are an outstanding example of versatility and striking power in modern carrier-based jet aircraft. Using a wide variety of armament, Cutlasses are designed to fly and fight as interceptors, fighters or attack planes.

Chance Vought Aircraft INCORPORATED

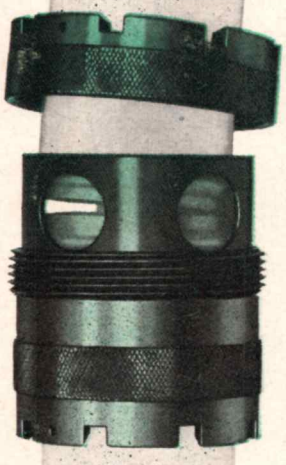
DALLAS, TEXAS

Are You Interested In WEIGHT REDUCTION?

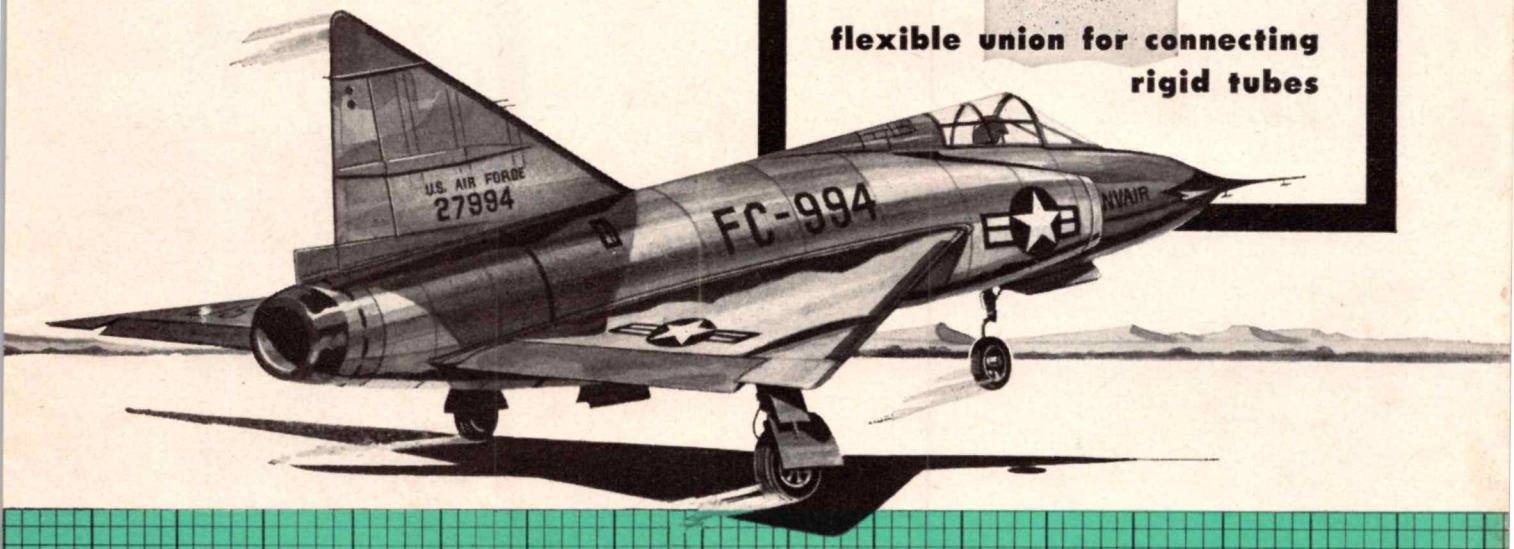
WIGGINS COUPLINGS SAVE 49 POUNDS ON CONVAIR F-102

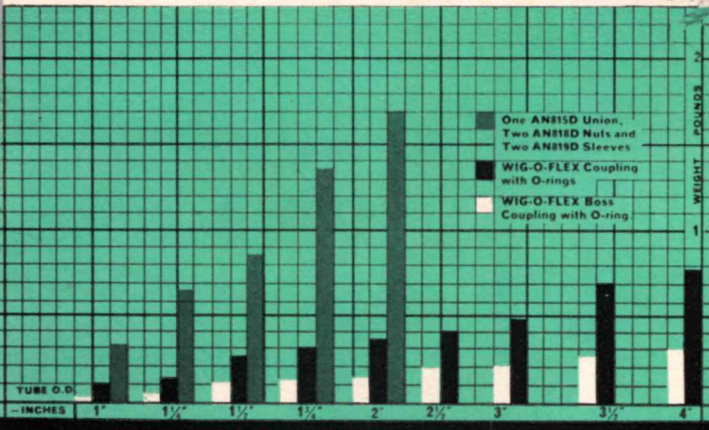
The new CONVAIR F-102 is 49 pounds lighter because WIG-O-FLEX Couplings replaced standard AN connections and cut hose. We are gratified that engineers at CONVAIR—the company that prides itself on "Engineering to the Nth power"—chose WIG-O-FLEX Couplings for a plane where weight was a major problem. The WIG-O-FLEX Coupling weighs 1/5 as much as the standard AN connection it can replace. (See weight chart for exact comparisons.)

WIG-O-FLEX COUPLING



flexible union for connecting rigid tubes





WEIGHT COMPARISON CHART
WIG-O-FLEX COUPLING & AN STANDARD FLARED TUBE CONNECTION

PROVED SUPERIOR FOR FUEL, OIL, AIR

- Withstands more than 1000 psi burst pressure.
- Accommodates 4° tube flexure.
- Installs locally. 80% lighter.
- Temperature range —65°F to +250°F.

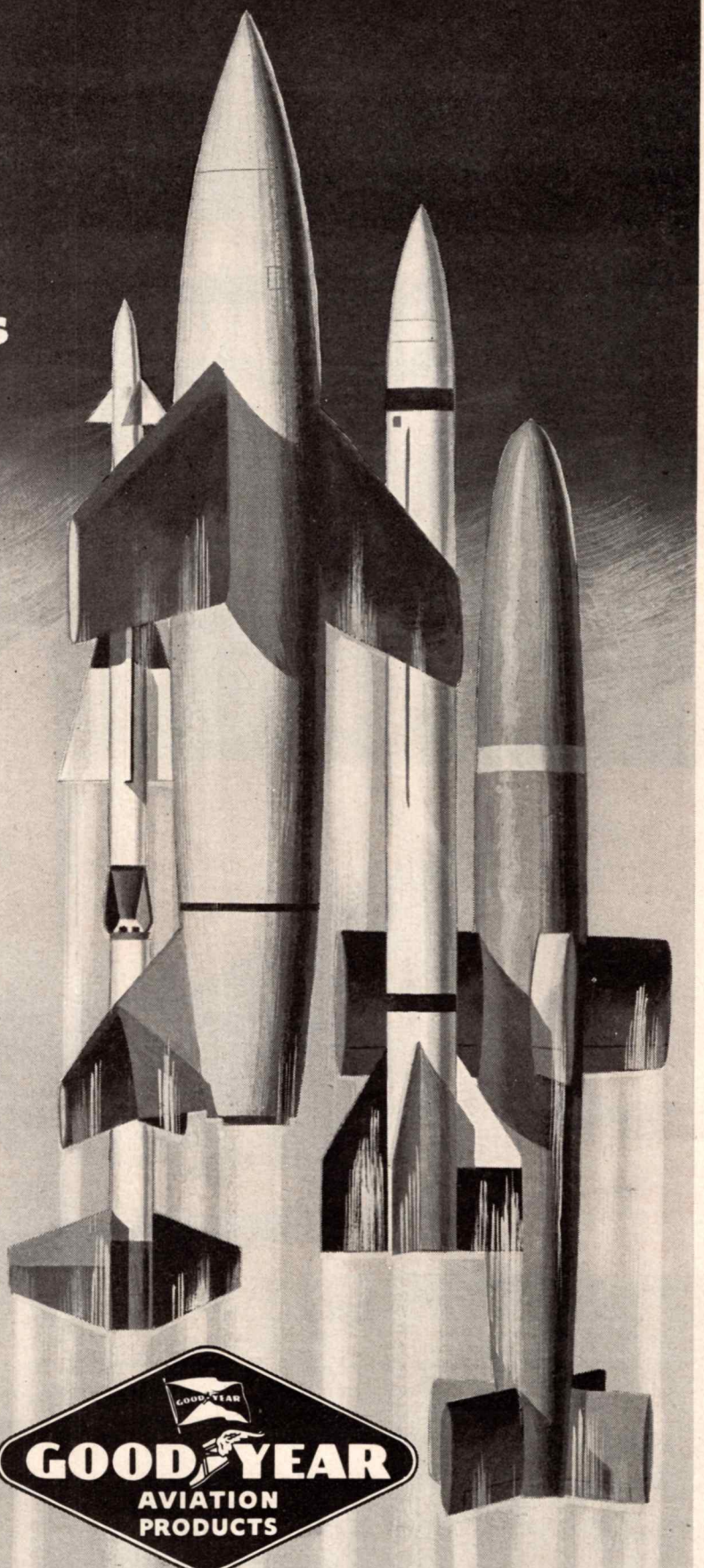
SIZES: 1" - 1¼" - 1½" - 1¾" - 2" - 3" - 3½" - 4"

WRITE FOR FURTHER INFORMATION

Wiggins

E. B. WIGGINS OIL TOOL COMPANY, INC.
3424 East Olympic Boulevard, Los Angeles 23, California

what makes a missile GO?



IN this age of guided missiles and pilotless bombers, the range of the weapons is often determined by the punch that can be packed into a limited amount of fuel.

Time and again, Goodyear Aviation Products Division has been called upon to cope with special problems posed by the new and difficult fuels being utilized for missile propulsion.

Our fuel cell experience and facilities have pioneered new ways of handling and stowing a variety of these fantastic fuels—and today we are busy on many more.

Working closely with our customers, we have licked searching problems concerning monopropellant and fuel- and oxidizer-systems – produced containers, diaphragms and expeller bags which withstand corrosion and extreme temperatures—found ways to safeguard many of these fantastic fuels from catalytic decomposition which otherwise could result in ruinous detonation.

COME TO US WITH YOUR FUEL CONTAINER PROBLEMS. You'll find willingness, desire, and facilities to work on your new developments—even on a limited scale. *You'll gain from the unrivaled experience offered by Goodyear in taming and actuating "flighty" fuels!*

Goodyear, Aviation Products Division
Akron 16, Ohio or Los Angeles 54, Calif.

GOODYEAR
AVIATION
PRODUCTS

FACILITIES + ABILITIES = EXTRA *plus* IN PERFORMANCE

AERO DIGEST
INCLUDING AVIATION ENGINEERING

VOLUME 69 . . NUMBER 4 . . OCTOBER 1954

Contents

MILITARY AIRCRAFT PROCUREMENT ISSUE

GENERAL NEWS FEATURES

MILITARY AIRCRAFT PROCUREMENT..... 21

Backlog continues high as administration's "new look" program builds toward 137-wing strength

DESIGN FORUM WINNERS 24

September winners in $5,000 AERO DIGEST contest revealed

AIRCRAFT ELECTRICAL SYSTEMS

DEVELOPMENTS IN AIRCRAFT ELECTRICAL POWER 26

By G. A. PHILLIPS

General Electric Co. engineer discusses new design principles that are solving increasing power, distribution and cooling problems

COOLING TECHNIQUES FOR AIRBORNE EQUIPMENT 33

By CECIL MARTIN

Analysis of available cooling methods by Jack & Heintz design engineer indicates steam system superior

DESIGN OF NEW ELECTRICAL POWER SYSTEMS 38

By C. K. MCBAINE

New methods developed for weight estimating of projected circuits and equipment discussed for first time by North American Aviation, Inc., design engineer

AIRCRAFT HYDRAULIC SYSTEMS

PROGRESS IN HYDRAULIC DESIGN ENGINEERING 42

By GEORGE MCLAUGHLIN

Increased power, reduced weight and improved efficiencies meet new system demands according to AERO's technical editor

HYDRAULIC ACCESSORY DRIVES 46

By CARL L. SADLER

Sundstrand Machine Tool Co. hydraulic expert points out the problems caused by new hydraulic demands

AIRCRAFT AIR-CONDITIONING SYSTEMS

HIGHER ALTITUDES BRING NEW DEMANDS... 50

By WALTER C. SHAW

Increasing performance of turbine aircraft requires new capacities and air-conditioning systems according to author, Project Engineer-Development, Hamilton Standard Division, United Aircraft Corp.

AIRCRAFT TESTING SYSTEMS

TRENDS IN AIRCRAFT TEST EQUIPMENT 53

By JULIUS KENDALL

Greer Hydraulics, Inc., specialist discusses equipment potential for mounting aircraft demands

AIRCRAFT HEATING SYSTEMS

AUTOMATIC TEMPERATURE CONTROLS FOR AIRCRAFT 62

By FRANK GLASSOW and W. F. TICE

Design problems, new techniques and ultimate goals outlined for future by Barber-Colman Co. authorities

AIRCRAFT COMMUNICATION SYSTEMS

ELECTRONIC COMPONENT DESIGN PROGRESS 68

By HARVEY A. SENIOR

Building blocks for assembly of versatile communication systems revealed

AVIATION EQUIPMENT

ACCESSORY UNITS 84

News of this important section of the aviation industry detailed for ready reference

DEPARTMENTS

AERO NEWS DIGEST 5

By FRED HAMLIN

A new look at airports . . . Heliport advance . . . Latest aircraft models . . . Procurement statistics . . . Names in the news

AIRBORNE ACCESSORIES CUTAWAY 80

By ROBERT MCLARREN

New aircraft component complexity shown in detail

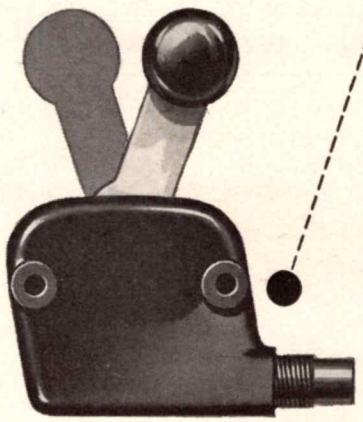
See page 14 for acknowledgments

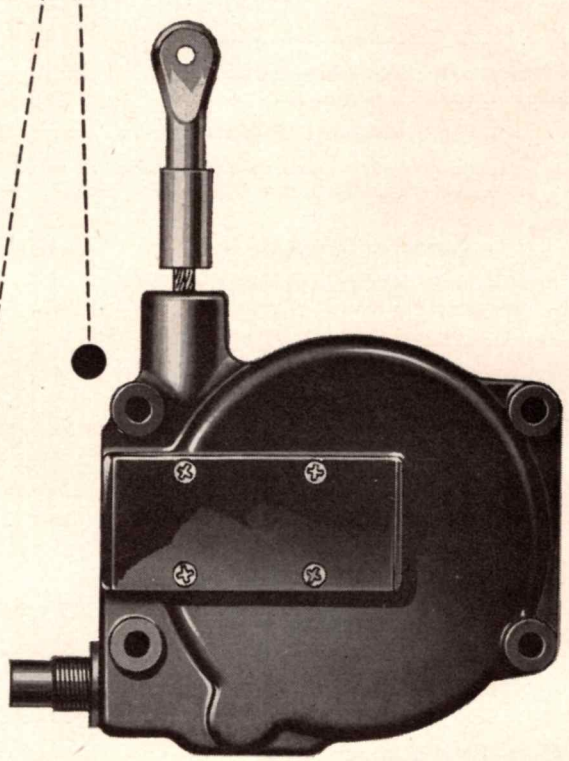
Aero Digest, 1954, Volume 69, No. 4. Published monthly by Aeronautical Digest Publishing Corp., editorial and executive offices, 511 11th St., N.W., Washington 4, D. C. Address all subscription correspondence to 515 Madison Ave., New York 22, N. Y. Entered as second-class matter at the Post Office at E. Stroudsburg, Pa. Subscriptions $3.00 a year in U. S. A.

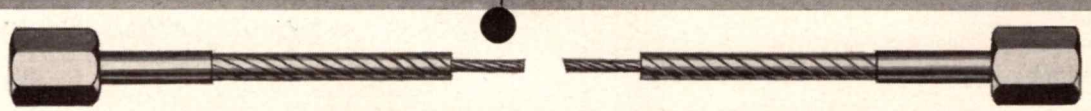
GET TO THE SEAT OF THE PROBLEM...

Pacific

No wiring . . . no hydraulics . . . no design or circuit problems. Fast, easy and economical installation on new or existing seats. Just six bolts and the Pacific Harness Reel is ready to operate!







only PACIFIC self-contained SHOULDER HARNESS REELS protect the seat occupant AUTOMATICALLY and INDEPENDENTLY of the airplane or its attitude!

Operating on a proven principle, the new Pacific Harness Reel works instantly and automatically on any force which tends to throw the pilot or crew member from the seat – *in any direction!* It permits full comfort and mobility – yet, with less than ½" of travel, snubs the user to a safe position when body accelerations exceed the reel setting.

Quick and easy to install, the Pacific Harness Reel is entirely mechanical. Simply mounted in any position on the seat, it is connected to the usual shoulder harness . . . no switches, no hydraulic, electrical or other power is needed, and the complete installation is the lightest in the field!

The Reel may be locked manually when desired and is designed to provide automatic locking on ejection seats. Whether locked manually, by ejection or by accelerations, the Pacific Reel is locked positively to provide complete pilot protection, and will not release until actuated by the manual control.

Now in volume production, the Pacific Harness Reel conforms with type MA-2 of MIL-R-8236 (U.S.A.F.). Write for details today!

Pacific SCIENTIFIC CO.

LOS ANGELES, CALIF., 1430 Grande Vista Ave.
SAN FRANCISCO, CALIF., 25 Stillman Street
SEATTLE, WASH., 421 Michigan Ave.
ARLINGTON, TEXAS, 111 East Main Street

FREE – mail this coupon for Bulletin MH-1 showing details, specifications and all the new features of the Pacific Harness Reel!

*Name*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

AERO NEWS DIGEST

THE COLD WAR GETS WARMER • "We must assume," says General Curtis E. LeMay, Commander of the Strategic Air Command, "that the time is now, today. We know who the potential enemy is, and we know what we are likely to run up against. All we have to do is be ready. When? I earnestly hope the answer is 'never.' Yet everything we do, every motion we make, must be based on one assumption — today." "Soviet strength is growing at a rate which challenges belief," says Senator Stuart Symington, former Air Force Secretary. "And who is so sheltered and uninformed as to believe for one moment that the Soviets will not strike as soon as they are confident of victory!" Both quotes point toward one conclusion: the cold war is going to reverse the seasons and become warmer during the coming winter and into the new year. While it may be an exaggeration to say that General LeMay's SAC is the only thing that keeps the Russians from striking now, certainly this and other ready-to-go defense organizations give the Soviet pause. And if they continue more strong than the Russians, the LeMay "never" may be the foreword of permanent peace.

* * *

NEW LOOK AT AIRPORTS • **Airports are changing with the coming of the jets. You can see one of the alterations in action at Lambert Field, St. Louis—a six-unit arresting gear system, the world's first on a commercial field. It was installed as part of a safety drive by McDonnell Aircraft Corporation, whose huge plant is at Lambert. Six arresting units, similar to those on flight decks of carriers, are in operation. Each has a braking force strong enough to bring a 125-ton steam engine going 60 mph to a dead stop in 600 ft. Not in operation yet, but destined to be even more conspicuous when installed, is another arresting device being built by All American Engineering Company, Wilmington, Del., for the Air Materiel Command. This runway barrier will look like a giant, elastic tennis net. It will be specially stressed for high-speed jets. Even more sensational from a visual standpoint is a new type of demountable airplane hangar, designed for the Air Force by Illinois Institute of Technology. The design features a double cantilever and is based on space-frame construction principles. A weblike structure, it can be put up in record time by unskilled labor.**

* * *

. . . AND HELIPORTS • With widespread use of commercial helicopters less than three years away, heliports should also soon begin to appear in downtown metropolitan areas. Spurring on this coming need, the Helicopter Council of the Aircraft Industries Association recently completed a survey indicating that the time for action in this department is yesterday. "For U. S. communities to take full advantage of helicopter air service," says Don Ryan Mockler, Director of the Council, "it is imperative that planning be started immediately." The Mockler group, which spent 18 months on its survey, finds that heliports will be easier to build than airports, but "steps should be taken to protect sites, with major attention on good downtown locations." He ends with a prediction: helicopters will use visual flight rules till about 1960, "when scheduled instrument flying with passengers should be feasible."

* * *

NEW MODELS • **Latest edition of North American Aviation's famed Sabre Jet (F-86K), has grown eight inches in the fuselage. Reason: to rebalance the plane due to shift in position of the armament, the K being a cannon-firing version of the D. An undisclosed number of K's have been ordered by the Air Force. The plane carries four 20-mm cannon instead of the 24 "Mighty Mouse" rockets in the interceptor version. . . . Newest twin-engine executive transport at Beech Aircraft Corporation is the "Super 18." Deliveries are scheduled to reach eight a month by October for the 8-place, 215 mph plane. Backlog of orders total over $4-million. . . . Douglas is in production on a DC-7C, a long-range version of the DC-7 which has been labeled the "Seven Seas." It will have ten ft. more wing span, three ft. more fuselage and two-ft. taller vertical tail structure. It will have an operating range of over 5000 mi., cruise at 350 mph with full payload, and is expected to go into operation by next summer. . . . Boeing B-47E's now coming off the production line**

Arresting gear recently installed at Lambert Field, St. Louis provides an extra landing safety factor for today's high-speed jets

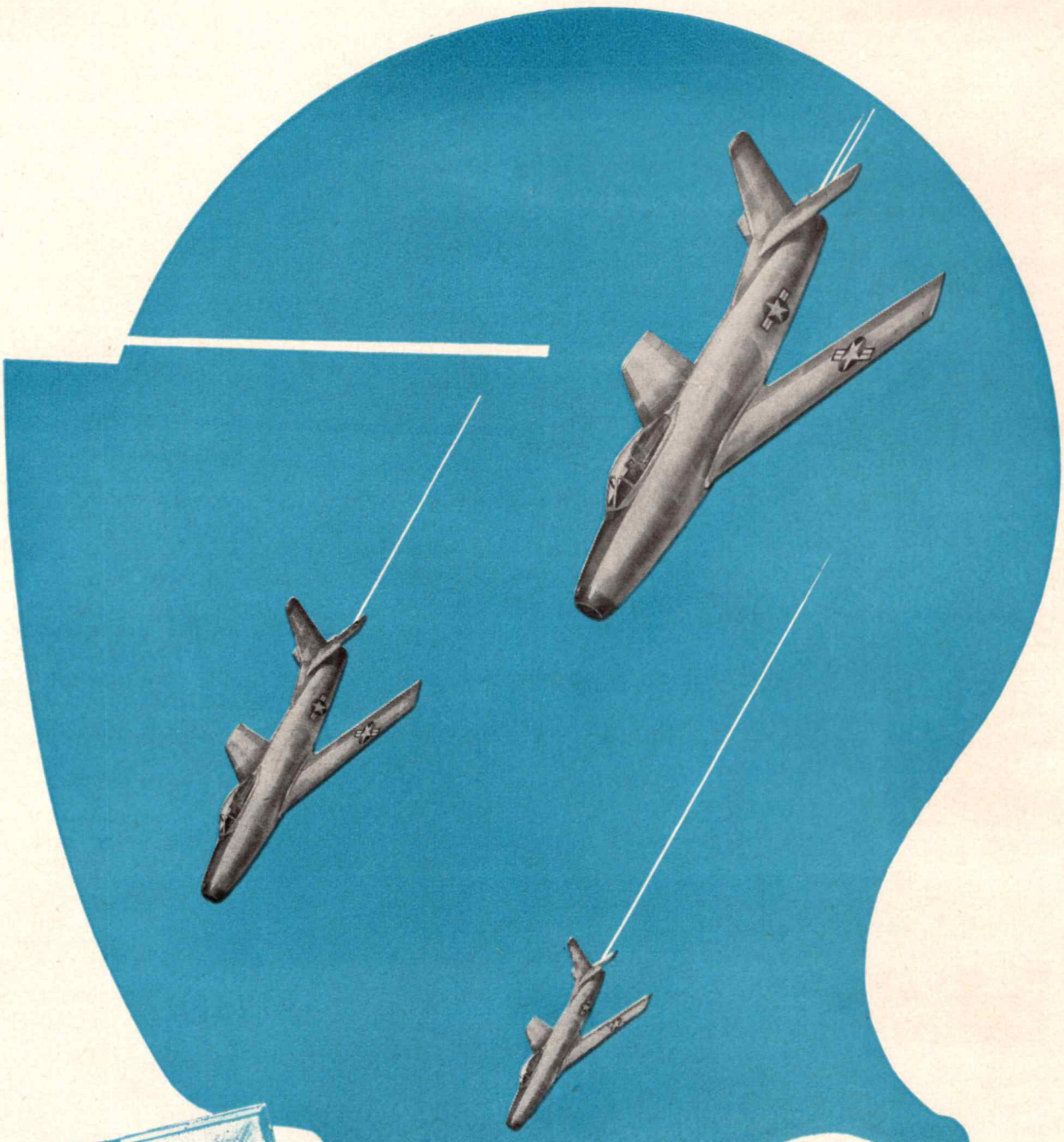
SAFETY by Swedlow

From "Knights of the Round Table" to the twentieth century "Knights of the Air" who do their jousting at supersonic speeds, armor has been a factor of safety in combat that cut casualties to a notable degree.

Swedlon Laminate XIG-112, approved under MIL. Spec. A-17856 (Aer) Armor fragm. non-metallic, protects the pilot at the most vulnerable points of the cockpit—on the floor, as protection against flak—in the backrest, as protection from bullets—and as protection for the vital electronic controls.

For information on this and other Swedlon laminate applications, contact the Swedlow plant nearest to you.

SWEDLON—armor for modern "knights of the air"



Swedlow PLASTICS CO.

LOS ANGELES, CALIFORNIA • YOUNGSTOWN, OHIO

have 50 percent more power than the prototype, now seven years old. Reason: General Electric J-47-25 engines are now being used, capable of 6000 lb. thrust each.

* * *

HELP WANTED • Jetliners may be long delayed in this country if military orders are placed to start production rolling. That is the word from Stockholm, of all places, but the spokesman knows what he is talking about. He is Arthur E. Raymond, Vice President-Engineering, Douglas Aircraft Company. He made the statement in a recent address before the Swedish Aeronautical Society. He points out that Douglas has already spent three years, a quarter of a million man-hours and $3-million on the DC-8 jetliner, but sees no possibility of real production without big orders. These, it was implied, can come only from defense funds.

* * *

PREVIEW OF EIGHTS • Raymond revealed a number of items on the DC-8, but hinted that a turboprop version of the DC-7 might go into production first. The jetliner, he said, will cruise at approximately 550 mph, have good low-speed and stall characteristics, a 30-degree angle of sweepback, and unusual flap efficiency. It will be long-range in a big way. . . . As for the turboprop DC-7, it will show 15 to 20 percent speed and economy improvements. Even this model, he added, is "several years" away.

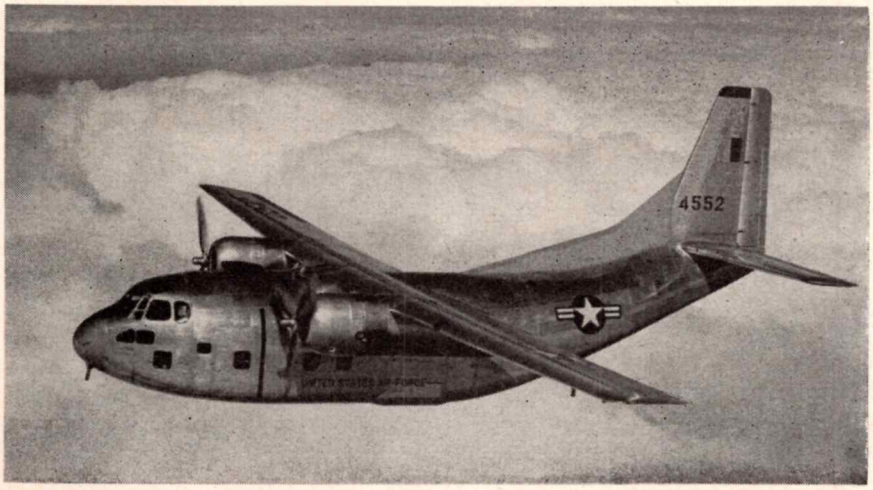
* * *

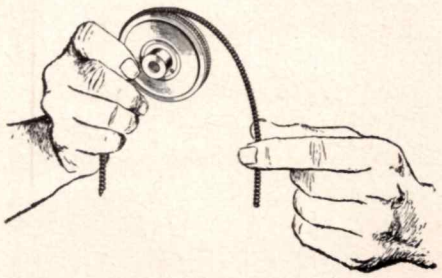
$$$$$ • A total of $656-million is still unobligated for procurement of guided missiles during fiscal 1955, when the Air Force program will become the largest of the three services. Until now, Army has led. Air Force has $461-million available in old and new funds, Navy $171. The Army, without new appropriations, has only $24-million in carryover money. All told, more than $2.5-billion has been appropriated for missiles since the Korean war began. . . Aircraft manufacturing backlogs dropped off 5 percent during the second quarter of 1954, 19 percent under the same period last year. The current backlog totals $15,247-million. Sales made during the second quarter totalled $2,165-million. . . Millions are being saved annually by aircraft plants through intensified reclamation programs. Martin reports a savings during the last year of over $360,000 in reclaimed hardware and another $222,000 in salvaged cartons, boxes and wood. And from Hawthorne, Calif., comes word that thousands of employe suggestions have resulted in savings totalling more than $2-million.

• • •

SPEED • Interesting sidelight in the current flight tests of the

Fairchild Aircraft's first production model of its new U. S. Air Force C-123B *Avitruc* assault transport is shown above on its initial flight of more than two hours. Fairchild modified, built and flew this version only 11 months after the company was awarded the Air Force prime contract to manufacture it. The *Avitruc* is in the 200 mph class with a top speed of over 240. It is powered by two Pratt & Whitney R-2800 engines developing 2500 hp at takeoff and has a range of 850 miles with a payload of 16,000 lb.





A new key to Accuracy...

IN JET ENGINE, MISSILE AND AIRCRAFT CONTROL LINKAGES

The unusual cable shown above is Teleflex—the unique "flexible rack" that is helping to solve mechanical motion problems in the control of jet engines, missiles and aircraft.

Take an example in the jet engine field . . .

PROBLEM: A highly accurate mechanical feedback linkage is required to complete a servo system loop. One end of the system is exposed to a 350°F ambient temperature.

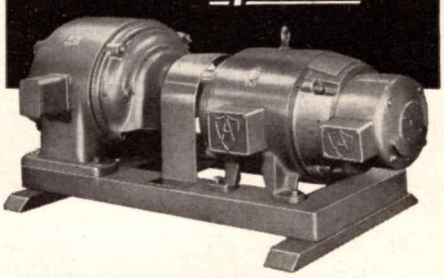
SOLUTION: A special control box was designed, with a hobbed wheel to engage the Teleflex cable. A spring-loading feature allows for a selection of spring loads up to 25 pounds, applied in either direction, depending on the individual mounting arrangement or system load. One system over 100 inches long, with 270° of bend, had only .022 inches of backlash. Under more favorable bend and length conditions, another system held backlash down to .005, using a similar control box.

Teleflex tubular conduit, routed along contours and around obstructions, guides the cable to remote locations, duplicating the motion at both ends of a system.

DESIGN ENGINEERS—For complete engineering data—send to Teleflex Incorporated, 125 S. Main St., N. Wales, Pa., for your copy of Catalog 400E.

TELEFLEX
MECHANICAL CONTROLS
LINKAGES MECHANISMS

Are your High-Cycle Alternator requirements *special?*



Where lowest possible maintenance, combined with excellent wave form characteristics are required, it's hard to match American Electric's Inductor-Type Alternators. But occasionally *special requirements arise* which may be better served by American Electric's Revolving Field Alternators.

Here Are Quick Facts:

AMERICAN ELECTRIC REVOLVING FIELD ALTERNATORS

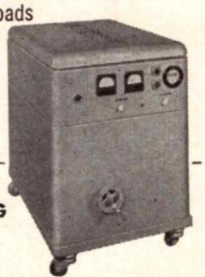
CAPACITY RANGE—15 KVA to 40 KVA (in stock). Up to 75 KVA on special order.

FAST RECOVERY—Better than .2 seconds.

LOW VOLTAGE OVERSHOOT—Less than 10%.

TOTAL HARMONIC CONTENT—Under 5% on unbalanced 3-phase loads

These characteristics apply to general uses. Where applications are specific, even better characteristics can be developed.



EXCITER REGULATING SYSTEM

Employs American Electric's trouble-free, direct-connected, high-cycle Inductor Alternator—which has no commutator, slip rings, brushes, springs etc. Output is rectified and exciter-regulated by either electronic or magnetic amplifier means then returned to the rotating field of the main alternator.

Write for details and quotations outlining requirements.

Also Manufacturers of High Frequency Inductor Alternators, Miniature Electric Motors, A.C. Industrial Motors, Motor Driven Blowers and Fans.

AMERICAN ELECTRIC MOTORS TRADE MARK

4811 Telegraph Road, Los Angeles 22, California

DIVISION OF AMERICAN ELECTRONICS, INC.
FIELD ENGINEERING REPREPRESENTATIVES:
Silver Spring (Md.) • Boston • Buffalo • New York City • Chicago • Dallas • Kansas City • Wright Field • Minneapolis • Seattle • Montreal • Toronto
JOE DAVIDSON & ASSOCIATES, Los Angeles

Douglas F4D Skyray is that an electronic machine is being used that is as fast in its field as the famous plane itself. Developed by Douglas, the machine can interpret flight test information 360 times faster than a human being, according to M. L. Van Doren, Douglas research engineer. He says that recording flight test instrumentation by interval camera could produce 216,000 points of information during an hour's test flight. To use this information would take 3600 man-hours at a minimum. The Douglas machine does the job in ten hours running time. It consists of an 88-channel airborne unit, ground station and data reduction facility. The airborne unit encodes during the test flight and transmits data to the ground station, where engineers monitor every movement of the flight. Housed in a van type trailer so that complete mobility can be maintained, the ground station has equipment to receive, observe, record and plot data. It includes a receiving system, data recording, data observation and data plotting systems.

• • •

NAMES IN THE NEWS • Two major appointments have been announced by **George F. Chapline,** Vice President and General Manager, Fairchild Engine Division, Fairchild Engine and Airplane Corporation. **Raymond I. Schneyer** is named Project Engineer of the new gas turbine laboratory being built along with the new multi-million dollar plant to be constructed at Deer Park, Long Island, N. Y. He resigned as Assistant Chief of the Gas Dynamics Facilities of ARO, Inc., at Arnold Engineering Development Center, Tullahoma, Tenn., to join Fair-

W. H. Dunning, new Pacific Scientific Company's Public Relations and Advertising Mgr.

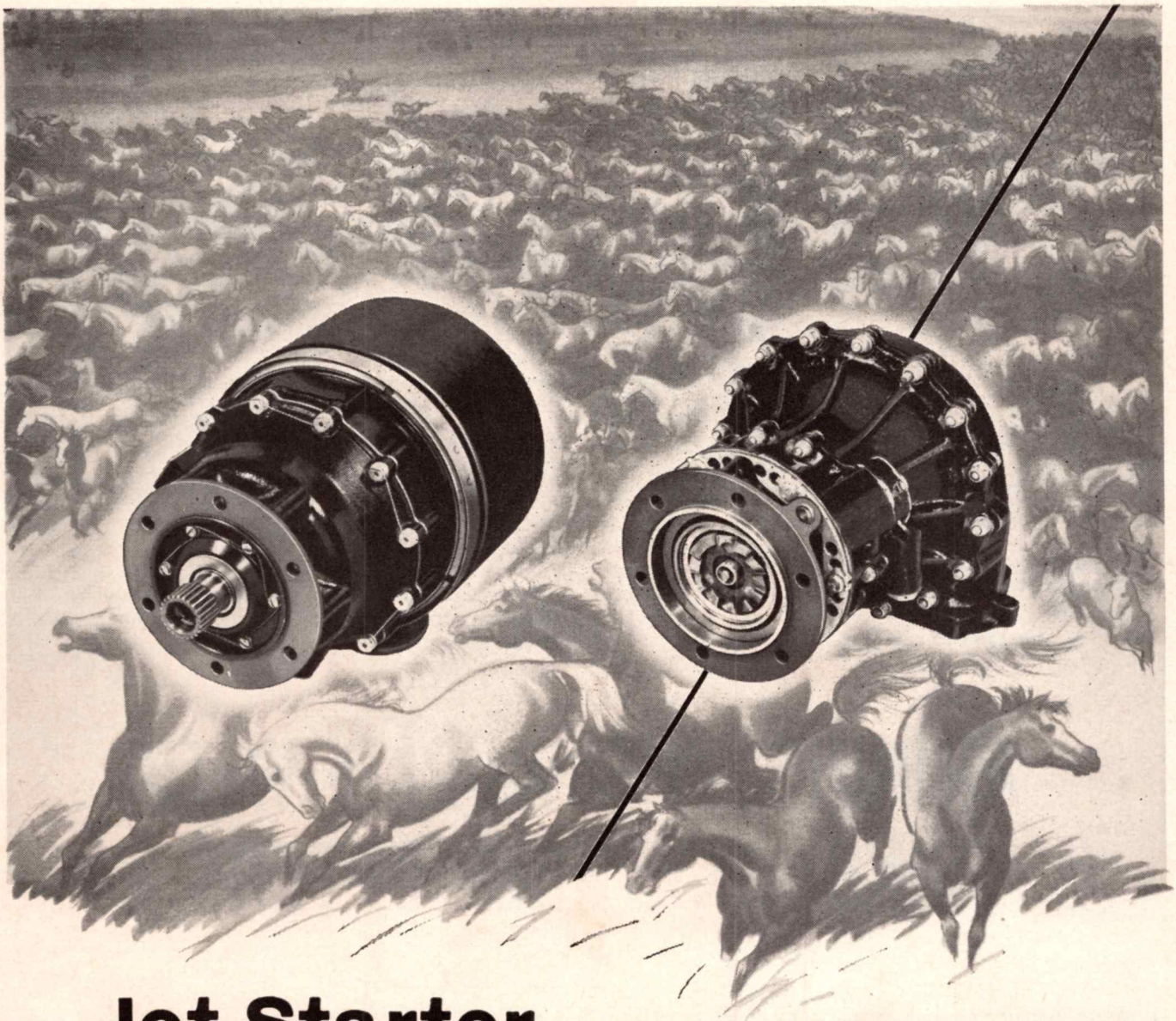
child. **Norman C. Witbeck,** formerly attached to the U. S. Defense Department as a powerplant specialist, will handle special-purpose aircraft powerplant projects as a Powerplant Specialist on the Fairchild Development Engineering staff.

Three top-level appointments are announced at Cornell Aeronautical Laboratory, Inc., by **T. P. Wright,** President. **Ira G. Ross,** head of the Wind Tunnel Department, has been named Director of the laboratory. In turn, he announces the promotion of **Robert S. Kelso** to head the Wind Tunnel Department. **David M. Pote** will succeed Mr. Kelso as assistant head.

W. H. Dunning is the new Manager of Advertising and Public Relations at the Pacific Scientific Company, Los Angeles, according to an announcement by **Decker G. McAllister,** President. . . **Dr. Louis G. Dunn** has resigned as Director, Jet Propulsion Laboratory, California Institute of Technology, to become Associate Director of the new Guided Missile Research Division of the Ramo-Wooldridge Corporation, Los Angeles.

C. Wayne Brownell has been appointed Director of Industrial Re-

Lockheed's *Super Constellation* equipped with jet-type turboprop engines made its maiden flight early in September. A Navy plane, designated R7V-2, it has a top cruising speed of 440 mph. Power is four Pratt & Whitney Aircraft T-34 turbine and propeller engines of 550 hp each, and special Hamilton Standard propellers 15 ft. in diameter with 2-ft.-wide blades. The Navy has ordered two R7V-2's and the Air Force has ordered two more, designated YC-121F's. Note that engine nacelles have large, over-the-wing outlets for turbine exhaust at the trailing edge of the wing



Jet Starter...

FOUR TIMES THE HORSEPOWER...LESS THAN TWICE THE WEIGHT!

At right (above) you see the *first* air turbine starter able to give continuous starts. This was pioneered by AiResearch in 1948. It weighed 17 lbs., produced 35 hp. and was used to start one of America's first turboprop engines: the Allison T-40.

But even then giant jet engines designed to produce 10,000 lbs. of thrust were on the drafting boards. Starting requirements were four times that of earlier jet engines. Could AiResearch create and manufacture such a starter, asked the Air Force.

AiResearch could — and did!

The answer is the unit at the left (above). Weighing only 27.5 lbs. and only slightly larger than the original model, it develops 140 hp. It is the only 140 hp. starter rugged enough to receive *unqualified* approval under Air Force qualification tests: MIL-E-5866A and MIL-E-5272!

Behind AiResearch starters are over 10,000 hours of operation in the laboratory and they have already produced over 100,000 successful starts in the field . . . evidence of the ability of AiResearch to deliver unusual power in small, light-weight packages.

AiResearch Manufacturing Company

A division of **THE GARRETT CORPORATION** *Los Angeles 45, California • Phoenix, Arizona*

Designers and manufacturers of aircraft components: REFRIGERATION SYSTEMS • PNEUMATIC VALVES AND CONTROLS • TEMPERATURE CONTROLS CABIN AIR COMPRESSORS • TURBINE MOTORS • GAS TURBINE ENGINES • CABIN PRESSURE CONTROLS • HEAT TRANSFER EQUIPMENT • ELECTRO-MECHANICAL EQUIPMENT • ELECTRONIC COMPUTERS AND CONTROLS

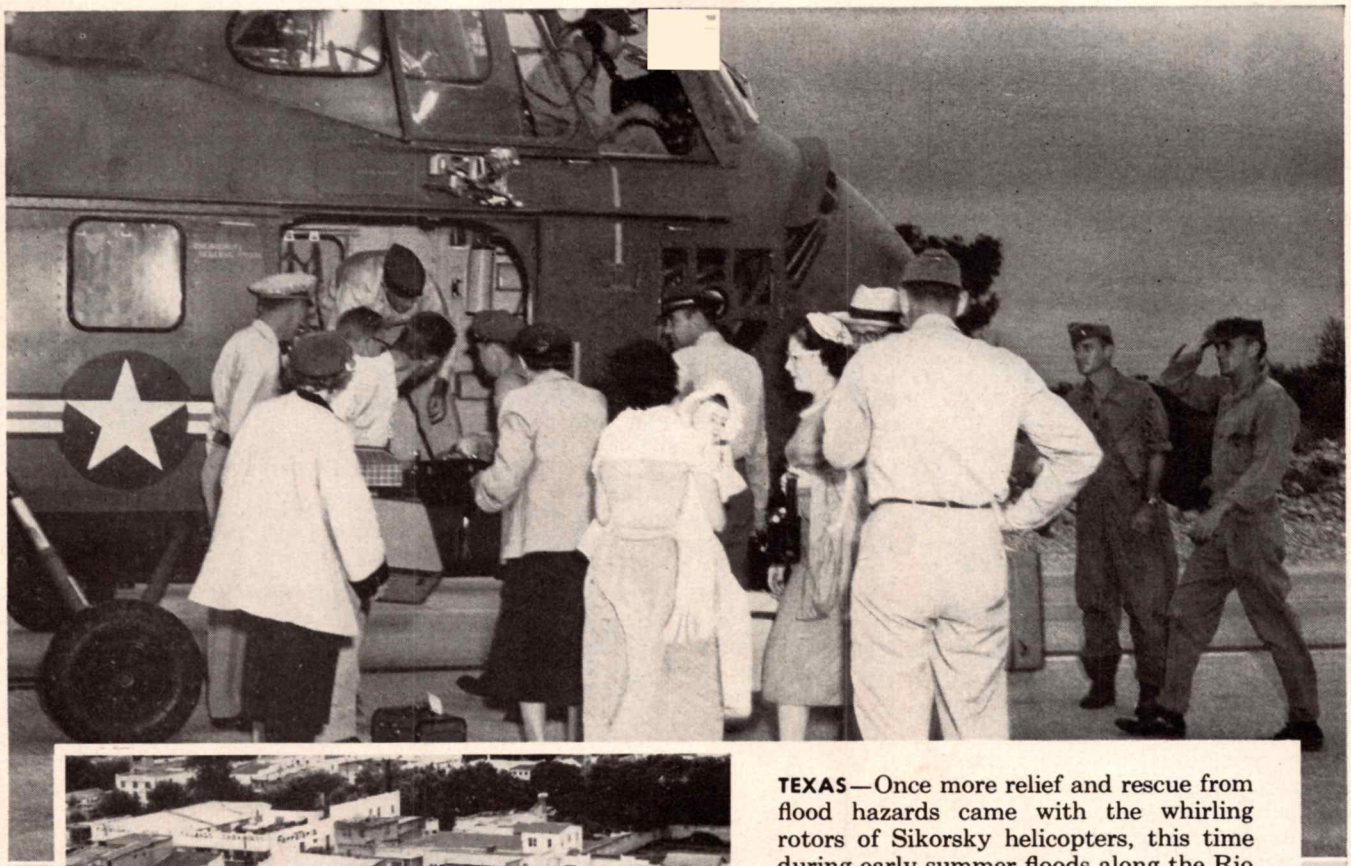
LONDON—Sabena Belgian Airlines recently linked England with Europe by an experimental helicopter flight, first ever made from the center of Brussels to the center of London. One of the airlines' Sikorsky S-55 passenger helicopters flew the cross-channel route in 2 hours 45 minutes, landing at London's South Bank heliport.

ANTARCTIC—Flying over ice-choked seas, S-55 helicopters from the Argentine Navy recently rescued 20 men virtually marooned for the past two years on Graham Land peninsula. The Sikorskys, operated from the deck of an Argentine transport vessel, made six round trips to bring the stranded men to safety.

AROUND THE WORLD WITH SIKORSKY HELICOPTERS

JAPAN—One of eleven Sikorsky S-55 helicopters built for Japan is pictured above being test flown with new flotation gear. This model is for Japan's official Maritime Safety Agency. Other Sikorsky S-55s are being delivered for service with air and ground branches of that country's National Safety Agency and Maritime Safety Agency.

INDIA—Civil purposes such as crop dusting or spraying, illustrated above, will be one major mission of three Sikorsky S-55 helicopters being delivered to the Indian Air Force. Because of their rugged dependability and large cargo capacity, versatile Sikorskys are in wide use for military and commercial purposes around the world.

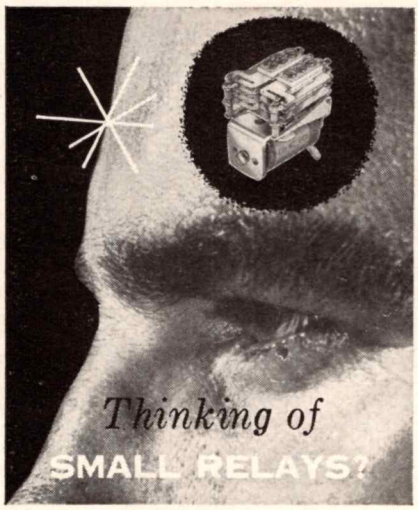


TEXAS—Once more relief and rescue from flood hazards came with the whirling rotors of Sikorsky helicopters, this time during early summer floods along the Rio Grande River in southwest Texas. In one big airlift alone, thirteen H-19s from Gary Air Force Base at San Marcos, carried 266 passengers from a railroad train stranded by the flood at Langtry. They flew precious drinking water and vital supplies to isolated areas, lifted victims from the torrent and marooned people to safety.

SIKORSKY AIRCRAFT

BRIDGEPORT, CONNECTICUT

One of the Divisions of United Aircraft Corporation



ADVANCE *builds 'em for heavy loads and long service!*

Cramped quarters don't cramp the style of ADVANCE midgets and miniatures. You can use them on loads up to 5 amperes continuously... and at three times their rating intermittently—with complete safety. They'll resist shock and vibration... stand up under temperature extremes. You'll find them readily adaptable to any mounting need... any type of duty. Here are a few examples:

"TINY MITE"

MM & MP SERIES

This ultra-small d-c relay occupies less than ½ cu. in. mounting space! It's stable under vibration and shock ...plated to prevent corrosion. Operate time is 5 milliseconds. Contact rating: .5 amp. or 1 amp.

MINIATURE TELEPHONE TYPE

TQ SERIES

Only .94 cu. inches in size, yet this relay carries 5-amp. loads in any combination up to 4 PDT. Mechanically secured throughout, it's extremely efficient. No gassing or bubbling. Withstands 10G vibration. Temperature range: —55° to +125° C.

Hermetic enclosures on these types are impervious to varying climatic conditions... are sealed and carefully checked against leakage.

Write for literature on any of the above series, or the complete ADVANCE line.

ADVANCE ELECTRIC AND RELAY CO.

2435-B NORTH NAOMI STREET
BURBANK, CALIFORNIA

Sales Representatives in Principal Cities of U.S. and Canada

lations, Bendix Products Division, Bendix Aviation Corporation, South Bend, Ind., by **George E. Stoll**, Corporation Vice President. . . **Clifford W. Sweeney** has been appointed Production Manager and **Clayman C. Shafer** Chief Methods Improvement Engineer, at Republic Aviation Corporation.

An Air Force commendation has been awarded to **Benjamin F. Greene, Jr.,** Electronics Engineer, Air Force Cambridge, Mass., Research Center, as the man primarily responsible for the development of VOLSCAN, the system of air traffic control that automatically selects and guides planes to landings at busy airports. . . **Beverly E. (Bevo) Howard,** Moultrie, Ga., and President of the Aeronautical Training Society, was recently made a Chevalier of the French Legion of Honor.

C. W. Lefever is the new Manager of Contracts and Customer Relations of American Helicopter, a Division of Fairchild Engine and Airplane Corporation, it is announced by **Corwin D. Denney**, General Manager. . . **Admiral Luis de Florez** is a new Director of the Pioneer Parachute Company, according to an announcement by **Lyman H. Ford,** President.

Arthur E. Raymond, Vice President - Engineering, Douglas Aircraft Company, has been awarded the Spirit of St. Louis medal for meritorious service in the advancement of aeronautics. . . Appointment of **Nicholas N. Solovioff** to head up the new Production Engineering Department of Greer Hydraulics, Inc., is announced by President **Edward M. Greer.**

Robert W. Henson, former Commander of Navy Helicopter Anti-Submarine Squadron Four, is the new Chief of Flight Tests, Ryan Aeronautical Corporation. . . **Robert L. Lewis,** formerly Assistant Manager of Manufacturing Control, TEMCO Aircraft Corporation, Dallas, has been named Assistant Director of Contract Administration.

Fred J. Baum, Manager of Northrop Aircraft's Dayton, O., office, has been elected an Assistant Secretary of the Company... The Radioplane Company, a Northrop subsidiary, also announces the appointment of **Robert Zimmerman** as Chief Staff Engineer for Program Planning, Weapons Systems, and **Jack Gearhart** as Senior Project Engineer.

New Executive Vice President, General Metals Corp., Burbank, Calif., is **Harold J. Mock,** former Guided Missile Manufacturing Director, Hughes Aircraft Co. . . Solar Aircraft Company, San Diego, announces the advancement of **Leon T. Noel** to Vice President-Finance and **Clifford W. Snider** to Comptroller.

Colonel George F. Hartman USAF (retired), now with Yardney Electric Corp.

Colonel George F. Hartman, USAF (Retired), is now Director, Aviation Applications Section, Yardney Electric Corp., New York. . . **Robert L. Earle** has joined Marquardt Aircraft Company, Van Nuys, Calif., as Vice President-Administration, it is announced by President **Roy Marquardt.**

Swedlow Plastics Company, Los Angeles and Youngstown, announces the following changes in Company officers: **John P. Endicott,** formerly Vice President and Treasurer, is now Executive Vice President and Treasurer; **Paul H. Bottoms,** formerly Secretary, is now a Vice President; **Fred M. Stefan** is now a Vice President as well as manager of the company's Youngstown division, and **William O. Fisher,** formerly Assistant Secretary, is now Secretary. **Dave Swedlow** continues as President and principal executive officer of the firm.

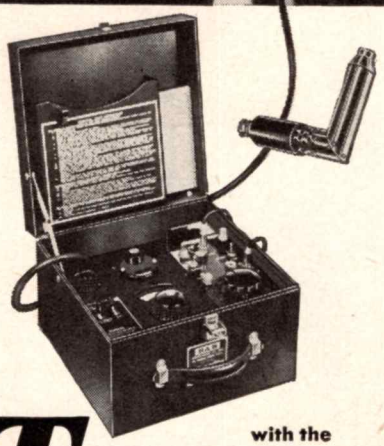
W. Paul Jones has left the Vice Chairmanship of Servel, Inc. board to become the new President of Kellett Aircraft Co. He has been Chairman of the 25-year old company for four years and will also continue to hold that position.

Duncan Cameron Menzies has been elected President, General Manager and a Director of Servel, Inc.

Two aviation old-timers made news during the past month. **Alexander F. Mannella,** Production Superintendent, Machining and Assembly, Hamilton Standard Division of United Aircraft Corporation, celebrated his thirtieth year with the company. And **Charles F. Kettering,** 78, who began flying with the Wright brothers before he became an auto executive, purchased a Piper *Twin Apache* with the idea of beating 72-year-old **William T. Piper's** recent record of being the oldest pilot with a twin-engine rating.

—FRED HAMLIN

Be Guided by summers
Products include: DYNAMIC ANALYSIS • FLIGHT SIMULATORS • INERTIAL GUIDANCE SYSTEMS • BOMB DIRECTING SYSTEMS • STABILIZED PLATFORMS • AUTOMATIC PILOTS • ILS LANDING SYSTEMS • YAW DAMPERS • SERVOS • INTEGRATING MOTORS DIRECTIONAL AND HORIZON GYROS • POSITION AND RATE (PAR) GYROS • INTEGRATING GYROS • TURN AND BANK INDICATORS • RADIOS
summers
Gyroscope Company
2328 BROADWAY • SANTA MONICA, CALIFORNIA
REPRESENTATIVES: H. A. WEBB, 34 MANN ST., FAIRBORN, OHIO; W. A. LAUKAITIS, SUITE 724, CAFRITZ BUILDING, 1625 EYE ST., N. W., WASHINGTON, D. C.; J. M. WALTHEW CO., BOEING FIELD, SEATTLE, WASHINGTON



with the

TEMPCAL

TEST OVER-HEAT DETECTORS and WING ANTI-ICE SYSTEMS ... RIGHT ON THE PLANE!

The TEMPCAL checks thermal switch and individual thermocouple ACCURACY.

TEMPCAL *functionally tests* thermal switches with their fire detection and anti-ice systems at their *operating temperatures* right on the aircraft ... and its relay circuit makes it possible to check *switches only* on or off the plane. Additionally, using a selected part of the TEMPCAL circuit, cylinder head temperature thermocouples and their circuits to the flight deck instrument can be checked.

ACCURACY—TEMPCAL Tester temperature readings are made on a highly accurate potentiometer; guaranteed accuracy is ±5°F with temperatures ranging from 0° to 800°F. Heater probes used for cylinder head thermocouples are guaranteed accurate to ±4°C at 0° to 300°C operating temperatures.

FASTER MAINTENANCE CHECKS—It is no longer necessary to take thermal switches to the "lab" for testing. TEMPCAL probes reach a temperature of 800°F in about 8 minutes for quick maintenance checks *on the aircraft.*

The production or maintenance engineer, pilot *and cost accountant* will readily realize the savings and safety factors resulting from TEMPCAL use. We invite inquiries concerning the TEMPCAL (as well as the JETCAL ..... for jet engine EGT system accuracy) *and will be glad to have our engineering department help solve your heat problems.*

b&h INSTRUMENT

B & H INSTRUMENT Company, Inc.

1009 Norwood FORT WORTH 7, TEXAS

AERO DIGEST

Including AVIATION ENGINEERING

PUBLISHED BY THE AERONAUTICAL DIGEST PUBLISHING CORPORATION

Editor and Publisher
Fred Hamlin

Assistant Publisher
Art Clawson

Associate Editor
Eleanor Thayer

Technical Editor
George McLaughlin

Associate Editor
Lynn Black

Art Director
James Fischer

Consulting Editors
Dr. Max M. Munk
Albert A. Vollmecke
Roy J. Sandstrom
O. E. Tibbs

Vice President
James Galloway

Circulation Manager
A. L. Verschoor

Director Research
Louis A. Safian

ADVERTISING • GORDON HORSFALL, Sales Manager

NEW YORK
T. J. Harford
D. C. Emery
155 East 42nd Street
Phone Murray Hill 4-7232

LOS ANGELES
J. C. Galloway
J. W. Harbison
816 West Fifth Street
Phone Mutual 8335

CHICAGO
H. Thorpe Covington
Richard F. Knott
7530 N. Sheridan Road
Phone Rogers Park 1-1892

OHIO
Richard E. Cleary
Louis C. Kessie
Commercial Bank Building
Berea, Ohio
Phone: Berea 4-7719

DETROIT
W. E. Fellows
702 Stephenson Bldg.
Phone Trinity 5-8216

SYRACUSE
Hadley A. Hill
1527 Teall Avenue
Phone 73-2523

NEW ENGLAND
Harold H. Short, Jr.
Holt Rd.
Andover, Mass.
Phone Andover 2212

LONDON
Hart & Barton
139 Strand, W.C.2
Phone Temple Bar 4171-2

TIBBS CONSULTING EDITOR

Mr. O. E. (Pat) Tibbs, Manager of Flight Test, Glenn L. Martin Co., Baltimore, Md., has joined AERO DIGEST as Consulting Editor. He was a member of the first class to graduate from Randolph Field (1931) and received his Air Corps commission at Kelly Field in October, 1932. Tibbs flew the air mail for the Army in Curtiss A-12 *Shrike* attack planes. He has logged more than 6000 flying hours in more than 100 different aircraft types. Tibbs will bring to our technical readership the seasoned judgment of one of the nation's best-known and most widely-experienced test pilots.

ACKNOWLEDGMENTS (left to right—top to bottom) 5—Lockheed Aircraft Corp. 7—Fairchild Engine and Airplane Corp. 8—Lockheed Aircraft Corp. 22—The Glenn L. Martin Co.; Sikorsky Div., United Aircraft Corp.; Lockheed Aircraft Corp.; Boeing Airplane Co. 23—Bell Aircraft Corp.; North American Aviation, Inc. 26—Boeing Airplane Co. 27-28-29-30-31—General Electric Co. 37—Jack & Heintz Corp. 44-45—Vickers, Inc. 46-47-48-49—Sunstrand Machine Tool Co. 55-56-58—Greer Hydraulics, Inc. 62-64—Barber-Colman Co.

Published monthly by the Aeronautical Digest Publishing Corporation, Editorial and executive office: 511 Eleventh St., N.W., Washington 4, D.C. (STerling 3-1944). Advertising office: 515 Madison Ave., New York 22, N. Y. (PLaza 3-6969) Officers: Fred Hamlin, President and Treasurer; John Ferguson III, First Vice President; James Galloway, Second Vice President; Arthur Clawson, Third Vice President; Eleanor Thayer, Secretary. Printed in U.S.A. Single copy: 50c. Subscriptions: U. S. $5.00 three years, $4.00 two years, $3.00 one year; Canada $6.50 three years, $5.00 two years, $3.50 one year. All other countries $9.50 three years, $7.00 two yars, $4.50 one year. When subscribing please mention connection with aircraft industry. Three weeks advanced notice required for subscription address change. Please include old and new address. Address all subscription corresponce to 515 Madison Avenue, New York 22, N. Y. We cannot replace copies not delivered through your failure to notify us of address change in advance. Re-entry as Second Class Matter at East Stroudsburg, Pa. under Congressional Act of March 3, 1879.

Copyright 1954 by Aeronautical Digest Publishing Corporation, New York, N. Y.

The Most Trusted Name in Ignition

Pioneers in Development of Vibration-Resistant Electrical Connector

The unsatisfied demand for a rugged, dependable connector capable of meeting the exacting requirements of modern aircraft led the Scintilla Division of Bendix* to develop the *first* vibration-resistant electrical connector. These connectors using the revolutionary new insert material known as Scinflex were first used on Scintilla Division's ignition equipment for piston engines.

So outstanding was the performance of this new and better connector that its acceptance and use have now become world-wide. Today the Scintilla Division is a major contributor to the electrical connector industry.

This pioneering has never stopped. Bendix was first in the field with cadmium plated connectors, which were later made a requirement of military specifications. Our latest contribution is the best engineered closed entry socket contact available anywhere—one which cannot be mechanically overstressed.

*TRADE-MARK.

SCINTILLA DIVISION

of Bendix AVIATION CORPORATION

SIDNEY, NEW YORK

AVIATION PRODUCTS: Low and high tension ignition systems for piston, jet, turbo-jet engines and rocket motors . . . ignition analyzers . . . radio shielding harness and noise filters . . . switches . . . booster coils . . . electrical connectors.

Export Sales: Bendix International Division • 205 East 42nd St., New York 17, N. Y.

FACTORY BRANCH OFFICES: 117 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Mich. • 512 West Ave., Jenkintown, Pa. • Brouwer Bldg., 176 W. Wisconsin Ave., Milwaukee, Wisc. • American Bldg., 4 South Main St., Dayton 2, Ohio • 8401 Cedar Springs Rd., Dallas 19, Texas

Bendix

—powered by new
ALLISON TURBO-JET ENGINES

The nation's newest reconnaissance bomber is the swift and versatile, twin-jet RB-66 – built for the Air Force by Douglas Aircraft Company, Inc. at Long Beach, California.

In the 600-700 MPH class, the RB-66 is powered by the new Allison J71 Turbo-Jet engine. This new power plant produces more thrust per square foot of frontal area than any other known engine.

A single compressor engine, the J71 offers substantial weight savings – with the same capability for quick field maintenance and repair as its predecessor, the Allison J35.

This new engine answers the Air Force's requirement for a high thrust, high compression ratio engine – employing simplicity of design and construction.

Because it meets this requirement, the J71 engine was selected for the RB-66 which will continue to carry out the Douglas tradition for building planes that can fly "faster and farther with a bigger payload."

GM
GENERAL MOTORS

Allison

Division of General Motors, Indianapolis, Indiana

World's most experienced designer and builder of aircraft turbine engines – J71 and J35 Axial, J33 Centrifugal Turbo-Jet Engines, T56, T38 and T40 Turbo-Prop Engines.

VICKERS®

A Single *Responsible* Source for Aircraft Hydraulic Products

PUMPS

a. Fixed Displacement
b. Variable Displacement
   (1) Automatic Pressure Compensated
   (2) Cylinder Controlled
   (3) Electrically Depressurized
   (4) Flow Reversing
   (5) Servo Controlled

ACCUMULATORS

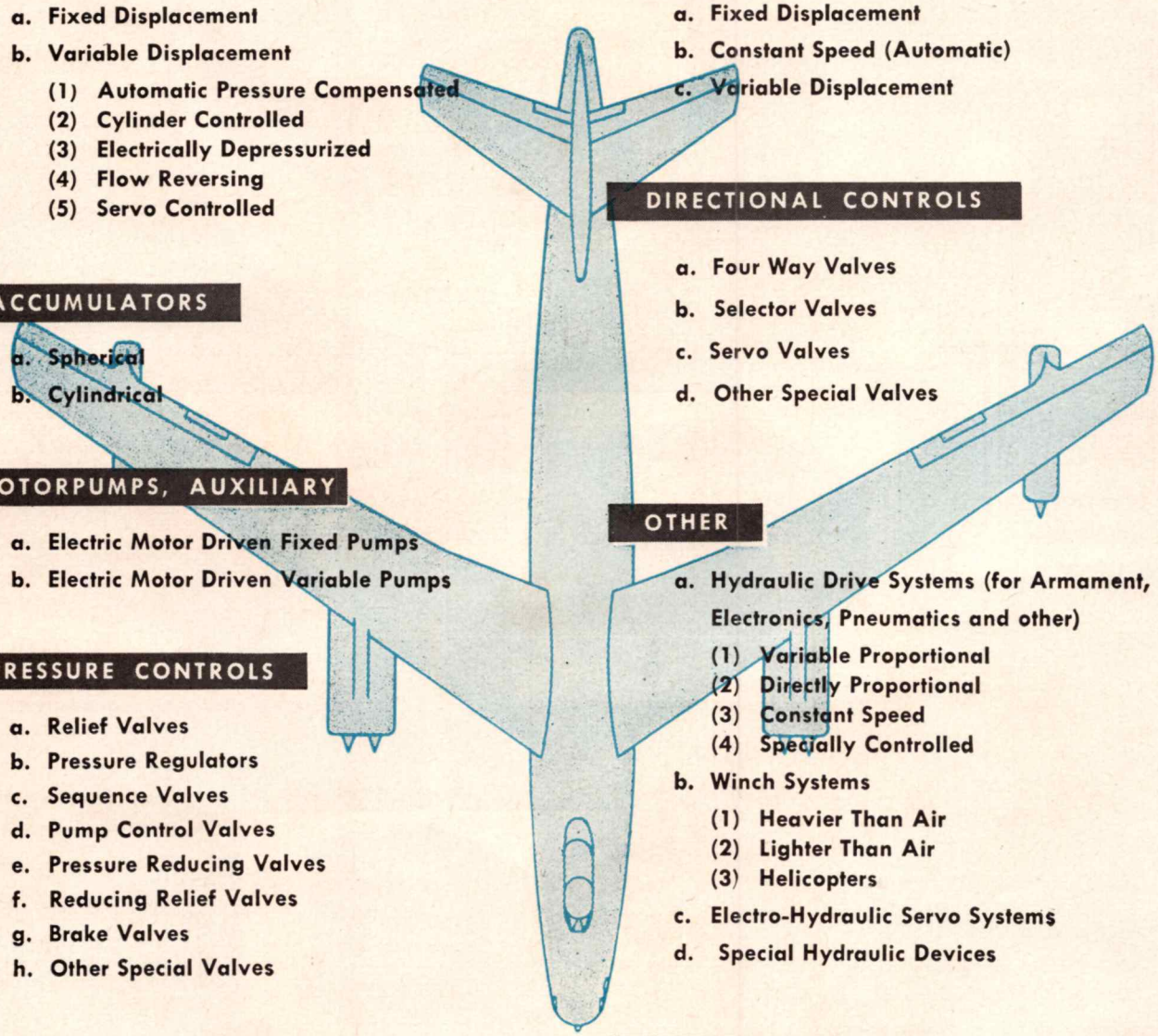
a. Spherical
b. Cylindrical

MOTORPUMPS, AUXILIARY

a. Electric Motor Driven Fixed Pumps
b. Electric Motor Driven Variable Pumps

PRESSURE CONTROLS

a. Relief Valves
b. Pressure Regulators
c. Sequence Valves
d. Pump Control Valves
e. Pressure Reducing Valves
f. Reducing Relief Valves
g. Brake Valves
h. Other Special Valves



MOTORS

a. Fixed Displacement
b. Constant Speed (Automatic)
c. Variable Displacement

DIRECTIONAL CONTROLS

a. Four Way Valves
b. Selector Valves
c. Servo Valves
d. Other Special Valves

OTHER

a. Hydraulic Drive Systems (for Armament, Electronics, Pneumatics and other)
   (1) Variable Proportional
   (2) Directly Proportional
   (3) Constant Speed
   (4) Specially Controlled
b. Winch Systems
   (1) Heavier Than Air
   (2) Lighter Than Air
   (3) Helicopters
c. Electro-Hydraulic Servo Systems
d. Special Hydraulic Devices

Various special devices not listed above are also manufactured. Phone, wire or write us for a proposal describing the aircraft hydraulic accessory required for your particular project. Details of the above products are available on request. Ask for the new General Bulletin A-5200-B which will introduce you to our complete Aircraft Products line.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1458 OAKMAN BLVD. • DETROIT 32, MICH.

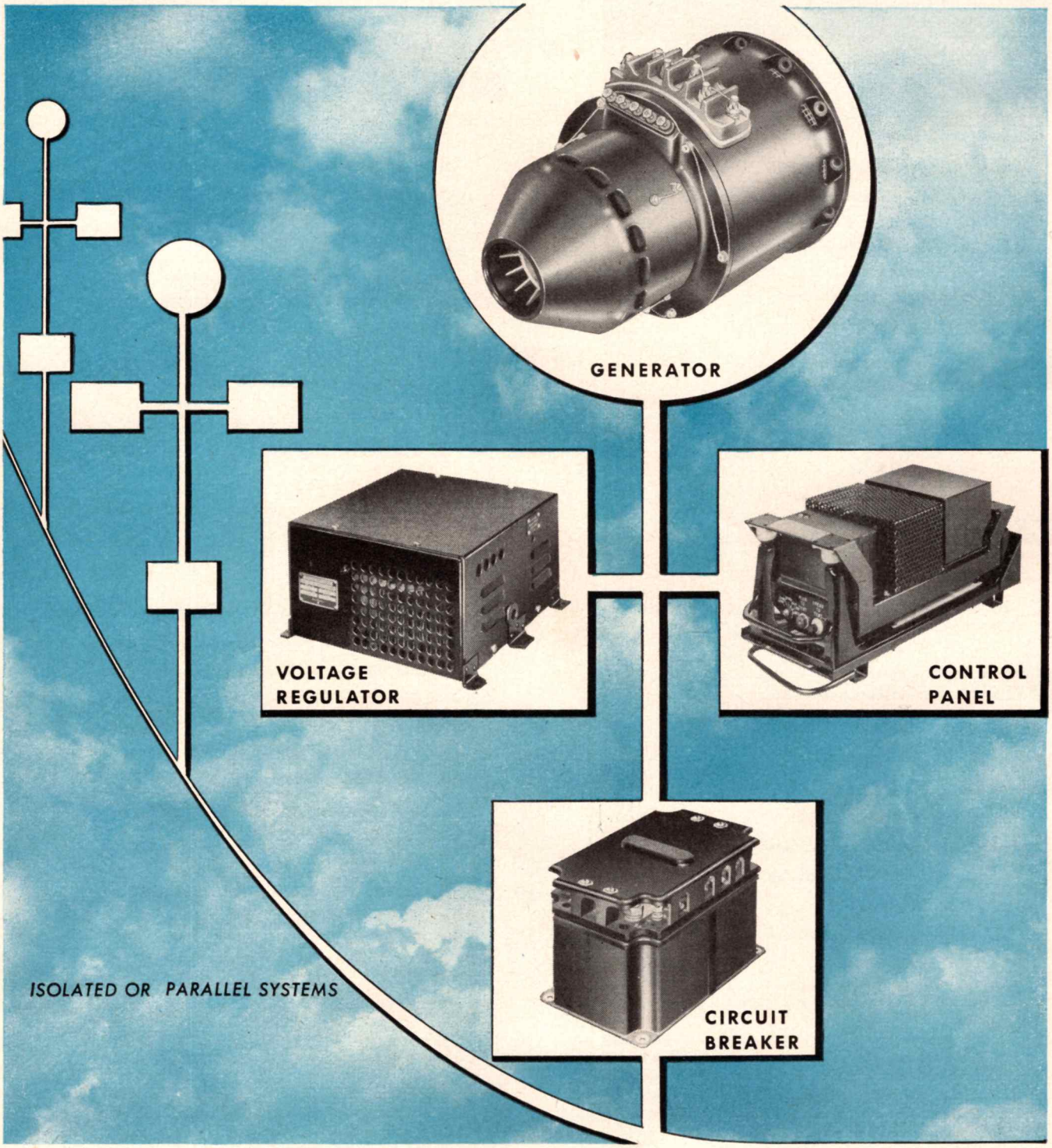
Application Engineering and Service Offices:
El Segundo, California, 2160 E. Imperial Highway
Houston 5, Texas, 5717 Kirby Drive
Detroit 32, Michigan, 1400 Oakman Blvd.
Additional Service Facilities at:
Miami Springs, Florida, 641 De Soto Drive

TELEPHONE: TOwnsend 8-5100 • TELEGRAMS: Vickers WUX Detroit • TELETYPE "TWX" DE89 • CABLE: Videt Detroit

6672

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

A-C SYSTEMS FOR AIRCRAFT



J&H JACK & HEINTZ

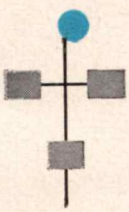
...a report from JACK & HEINTZ

Wide range of a-c systems... result of expanded J&H Generator line

Jack & Heintz now offers the aircraft industry complete alternating-current systems and components "tailored" to meet the demands of tomorrow's high-performance aircraft.

With the expansion of its a-c generator line and extensive experience in the development and production of a-c control panels, regulators and other auxiliary components, J&H can now supply a-c systems ranging from 3 through 120 kva. These systems are capable of isolated or parallel operation.

MAJOR SYSTEM COMPONENTS

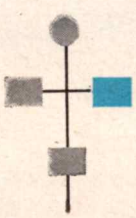


GENERATORS: Designed to MIL-G-6099 and applicable drawings, J&H a-c Generators are among the smallest and lightest yet developed. Available models include cooling by blast air, oil or vapor.

Important features include:

Light weight* · High efficiency*
Low harmonic content* · Phase balance*

*Better than required by MIL-G-6099 and applicable drawings.

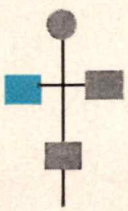


CONTROL PANELS: Designed to applicable USAF and Navy specifications, J&H Panels can also be built to special requirements. They can operate either from the d-c bus or independent of it.

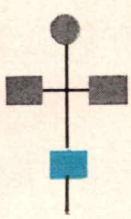
J&H Panels include any or all of the following functions (which can be supplied as individual components, if desired):

Generator control-relay · Over-voltage protection† Undervoltage protection · Phase-sequence protection · Under-speed or under-frequency protection Anti-cycling · Power indication · Field flashing Special interlocking

†Overvoltage relay is insensitive to acceleration forces.



VOLTAGE REGULATORS: Designed to MIL-G-6099 and applicable drawings, J&H Regulators are of the static-magnetic-amplifier type. Weighing only twelve and one-half pounds, the regulators feature a magnetic reference eliminating the use of electronic tubes. Provision is made in all regulators for reactive load division function.



CIRCUIT BREAKERS: Designed to MIL-C-8379, J&H Circuit Breakers have the following outstanding features which make them exceptionally well suited for use on high performance aircraft:

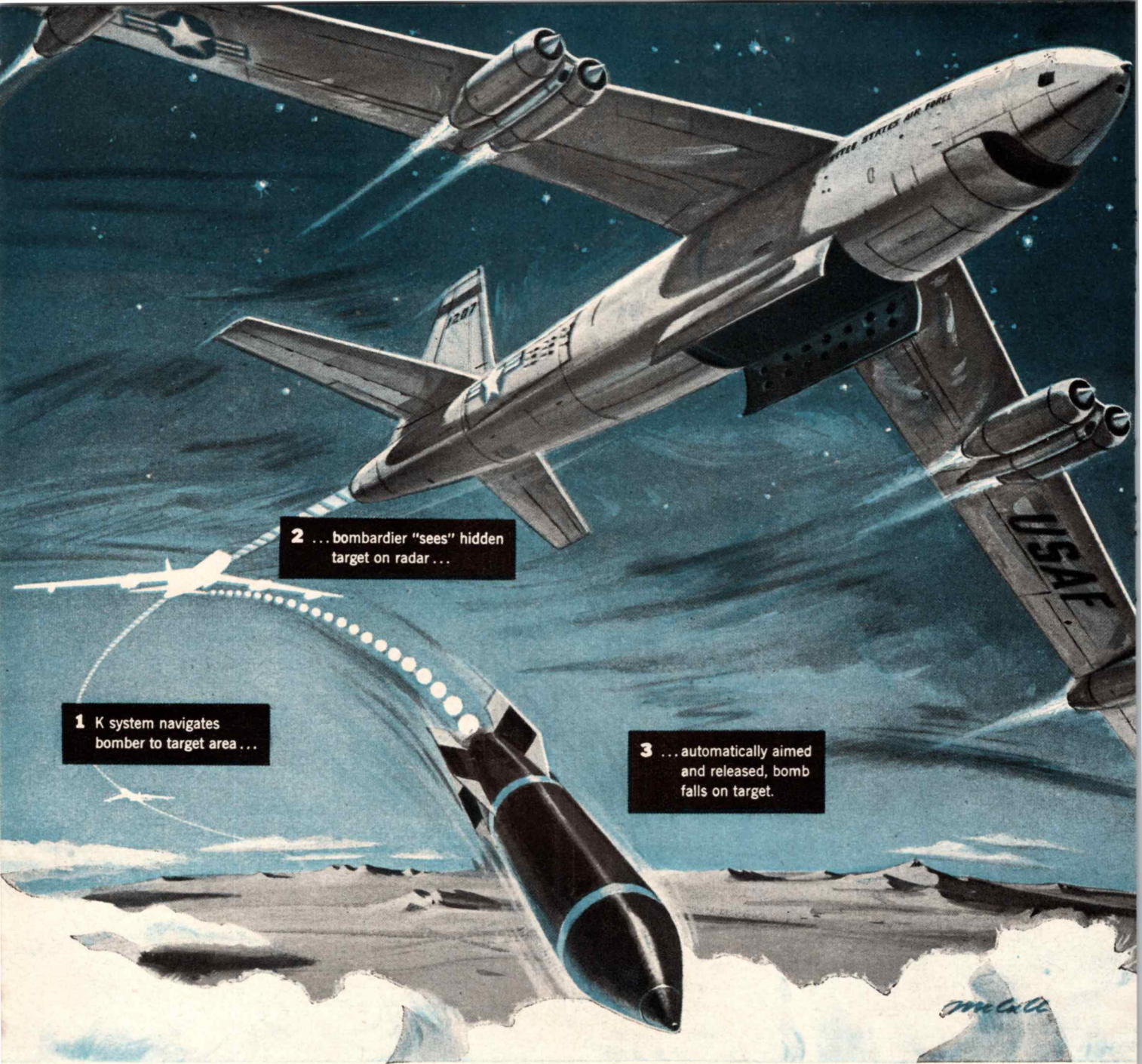
Balanced rotary latch
Direct solenoid-actuated contacts
Noncritical adjustment of interlock contacts
Easy inspection of main contacts

OTHER COMPONENTS: In addition to the panel functions which can be supplied as individual components, Jack & Heintz has developed transformers, reverse power relays, phase sequence relays and other auxiliary a-c system components.

Jack & Heintz engineering personnel and manufacturing facilities are geared to undertake design and production of complete a-c systems or individual components. We invite your inquiry. Write Jack & Heintz, Inc., 17631 Broadway, Cleveland 1, Ohio.

©1954, Jack & Heintz, Inc.

Rotomotive AIRCRAFT EQUIPMENT


2 ...bombardier "sees" hidden target on radar...
1 K system navigates bomber to target area...
3 ...automatically aimed and released, bomb falls on target.
USAF

USAF DESTROYS UNSEEN TARGETS; PLANES USE RADAR BOMBSIGHT

THE STORY BEHIND THE STORY:

■ You've read headlines like the one above, reporting the precision of Air Force bombing—during tests. Within hours after an aggressor attack, you would read them again—reporting deadly counteraction. Night or day, regardless of weather, America can carry out its policy of instant retaliation to any aggressor—in any part of the world.

■ Now in large-scale production, the Air Force K Bombing System combines automatic navigation with all-weather identification and bombing of any target. With the aid of the Sperry Gyropilot* Flight Control and the K System, the crew flies the high-speed bomber to the target area. Using the Sperry-designed Bombing Navigational Computer, the bombardier locates the target optically, or if hidden, by radar. The effects of speed, altitude and wind on the falling bomb are automatically computed, enabling the bombardier to score direct hits. In simplifying the complex job of bombing at extreme altitude from high speed jets, the K System permits more time and flexibility on the bomb run . . . more certainty of "mission completed."

■ There's little resemblance between this automatic "brain" and the first bombsight developed by Sperry for use in World War I—a simple telescope and range scale no larger than an egg beater. But both were made possible because a military-industry team anticipated the needs of modern defense—then met those needs with a strategic bombing program which authorities credit with helping to prevent a new global war.

*T.M. REG. U.S. PAT. OFF.

SPERRY GYROSCOPE COMPANY

DIVISION OF THE SPERRY CORPORATION • GREAT NECK, N.Y.

Military Aircraft Procurement

Industry backlog high as administration's "New Look" program builds toward 137 wing strength

BARRING war—that seemingly permanent contingency in U.S. life during this decade—the government now has a fixed, long-range aircraft procurement program. This idealized goal of the industry, for all its reasoned soundness, is based on so many utterly unstable assumptions that it is, at best, a wild hope for the future. Nevertheless, it is there and, comprises a genuine working partnership between the aircraft manufacturing industry and its number one customer, the military.

Following the contradictions and heated debates of last year, the new Joint Chiefs of Staff, chairmanned by Admiral Arthur Radford, evolved the "new look" in national defense. This is described variously as a prime dependence on air power, a permanent military posture of readiness and a fool's paradise, depending on which commentator you read. Assuredly nobody can say flatly how much defense is "enough," but the combined experience and judgment of the Joint Chiefs of Staff comes as close to qualifying for the task as is available.

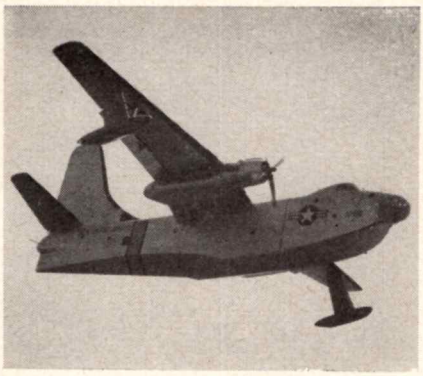
The Joint Chiefs, after presumably informed and tortuous study, has decided that 137 air wings, 16 carrier air groups and three Marine air wings is "enough" air power for the nation in the foreseeable future. Only the future can tell the correctness of their appraisal. But regardless of its adequacy it is—at last—a firm program.

This ordered strength exists in varying degrees in the flying services. The Navy already has its full 16 carrier air groups, the Marines their three air wings. Their task for the future is to obtain new aircraft at the precise level needed to maintain this strength and to

modernize all these units as rapidly as possible.

The Air Force, in contrast, must build steadily and rapidly toward its assigned strength and, while doing so, improve aircraft quality and performance. At this writing, USAF is running ahead of its schedule and there are 116 wings in service. All USAF fighter wings are now jet-equipped, and about 80 percent of all combat wings are equipped with jet aircraft. According to the present program, 90 percent of all USAF combat wings will be jet-equipped by June 30, 1955.

The quality of U.S. military aircraft is superior to that of any other nation and on this characteristic rests our ability to defend ourselves against admittedly larger forces of the Russians. The United States now holds the vast majority of all the important world's air records. The all-out speed record was contested strenuously by the British last summer but both U.S.



U.S. Coast Guard's Martin P5M-1

Navy and Air Force aircraft bested them.

The question of air records vis-a-vis the Russians may, or may not, be significant. It is the opinion of Washington sources that the Russians, if they could win, would definitely submit world's record performances to the F.A.I. for homologation. This they did consistently in the past. It seems a reasonable assumption that their failure to submit new claims is prima facie evidence of inferior performance.

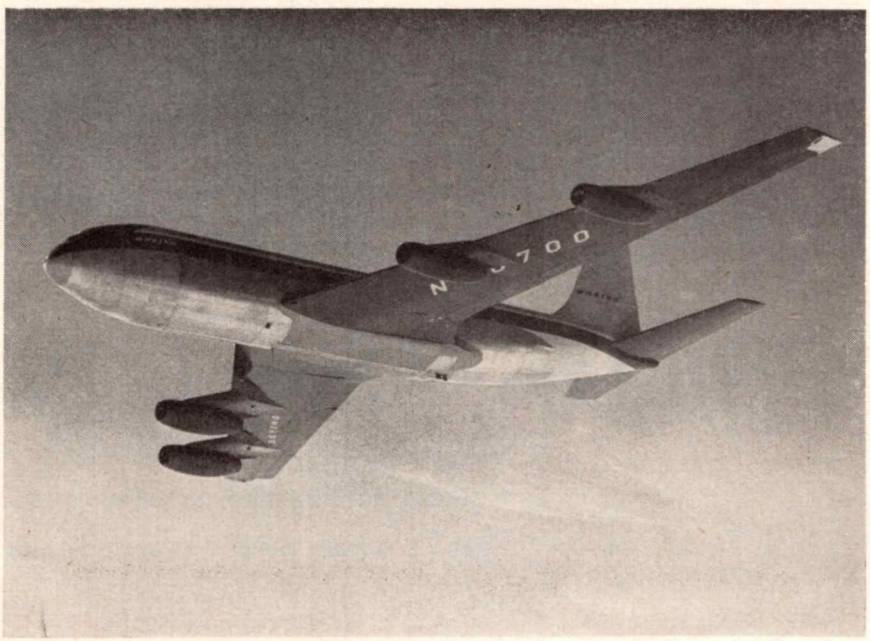
The air-atomic concept has been gradually losing its steam in the face of apparent Russian success

Sikorsky XH-39 (above), Navy's new Lockheed R7V-2, world's fastest propeller-driven transport (below)

MILITARY AIRCRAFT PROCUREMENT

Service	Fiscal Year	Fiscal 1955	Change
U. S. Air Force	$3,495,000,000	$2,760,000,000	—$735,000,000
Naval Aviation	1,379,000,000	1,973,568,000	+ 94,568,000
Total	$4,874,000,000	$4,733,568,000	—$640,432,000

Boeing 707 jet prototype on test flight



with both the H-bomb and the long-range bomber. There has been a noticeable policy shift in the speeches coming from the Pentagon over the past year with less emphasis on "massive retaliation" and more emphasis on the need for strengthened air defense. Radford makes repeated pleas bordering on the defensive to the effect that no "single weapon" can do the job and that all services are needed. This is a platitude, of course, but its recent stressing would seem certain indication that the Pentagon has changed its view of the all-out importance of the Strategic Air Command in our defense system.

The old bugaboo of aircraft complexity has been attacked vigorously over the past year, epitomized by Douglas El Segundo's A4D single-seat carrier attack plane, known widely as the "Heinemann Hot-rod" after its chief designer. Simplification has made steady inroads on combat aircraft design, but America's best efforts in this direction were reduced to virtual insignificance by Britain's Folland "Midge." Weighing only 6,000 lbs., the tiny jet fighter is credited with doing everything the current fighter does, and yet costs only about one-fifth the time and money of the standard article. Whether this is a positive trend in the making cannot be deciphered at this writing, since it represents a concept and not a mere design exercise.

Defense Department reveals it has received more than $2.5-billion for missile expenditure since the start of the Korean war in mid-1950. The 1946-50 period probably saw another billion in research and development programs. This fabulous expenditure should, in theory, be a significant index to this nation's international stature in the missile field. Assuredly the security curtain has been deftly folded back on numerous occasions to reveal some of the products of the monstrous program, but each sample has been invariably characterized as an interim type with the best yet to come. No general or admiral has yet given his complete approbation to the U.S. missile program. The consensus would seem to indicate we are still trying harder to obtain the better missile than we are to create a missile force in being.

Procurement procedures and practices have taken a full turn for the better during the past year. Lines of authority have been greatly clarified and strengthened. Much of the doubletalk in the weapons system concept has been rewritten into plain, simple language.

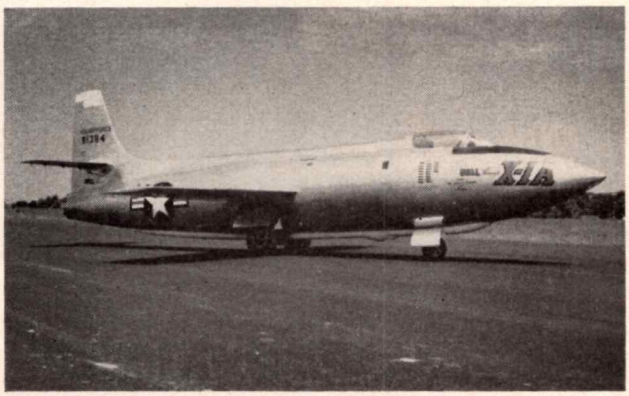
More so than ever, however, equipment continues as the backbone of our air power effectiveness and it is to this burgeoning industry that this special issue is dedicated. END

USAF 137-Wing Program
June 30, 1957

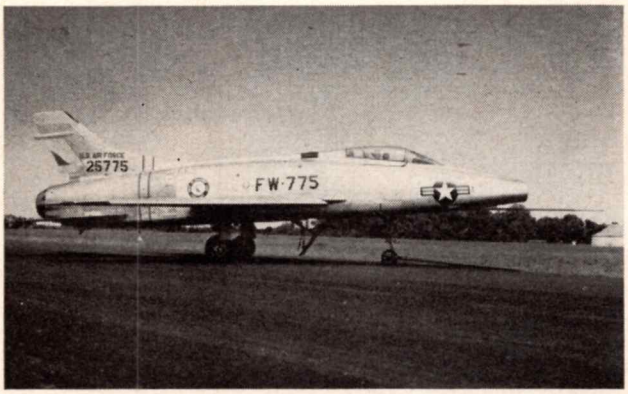
No.	Type	Aircraft
54	Strategic Wings	Convair B-36, Boeing B-47, Boeing B-52, Republic F-84F, North American F-86, North American F-100, McDonnell F-101
34	Air Defense Wings	Northrop F-89, Lockheed F-94, Convair F-102
38	Tactical Wings	Martin B-57, Douglas B-66, Republic F-84, North American F-86, North American F-100, Fairchild C-123
11	Airlift Wings	Fairchild C-119, Douglas C-124

U. S. AIR POWER PROGRAM

	June 30, 1954	June 30, 1955	June 30, 1956	June 30, 1957
Air Force				
Combat Wings	99	107	115	126
Airlift Wings	16	13	12	11
Total	115	120	127	137
Naval Aviation				
Carrier Air Groups	16	16	16	16
Marine Air Wings	3	3	3	3
ASW Squadrons	15	15	15	15
Aircraft Inventory				
USAF	21,010	22,927	23,460	24,710
Naval Aviation	13,285	13,191	13,250	13,250



Bell's X-1A ready for take-off

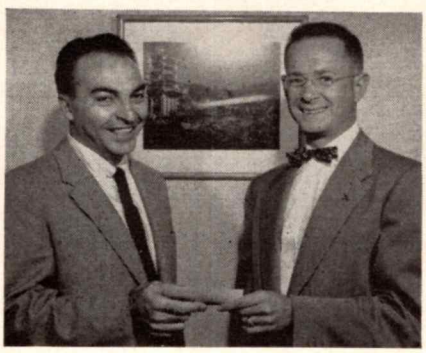


North American F-100

AERO DIGEST design forum WINNERS

SEPTEMBER, 1954 CONTEST

AN instrument face, a washer and a modern application of one of the world's oldest metal crafts are the winners of the September AERO DIGEST Design Forum, which closed October 1. Three more sets of monthly awards, totalling $475.00 each, will be announced at the closing of each competition, on Nov. 1, Dec. 1 and Jan. 1. Following the final monthly closing, announcement of Annual Awards totalling $1,625.00, will be made. Complete details on the Design Forum Competition are outlined on Page 86.



Last month's first prize winner, Manuel C. Sanz (left) receives check from Dale Myers for his Chem-Mill entry

First prize this month is for a qualitative instrument face which uses, in the author's words, "human engineering principles long known to psychologists, but incorporated here for the first time in the design of a dial." Purpose is to produce safer and more efficient operation of a machine system, such as an aircraft.

The new display system is designed to eliminate sources of error found on current designs. It is based on the psychophysiological principle that the human brain can visually perceive and interpret simple high contrast figures of known symbolism much more readily than it can perceive and react to a complex process, such as reading a scale.

September second prize goes to a new washer that makes possible more accurate preloading of bolts used in aircraft assembly. The washer is already in use at Douglas Aircraft Company, and will be available to the industry as soon as licensing arrangements are completed.

Tests show that is can be designed to assure an average tension preload of 80 percent of the desired bolt preload with slight deviations. Result is a sharp increase in the fatigue life of the bolts, and tighter assemblies.

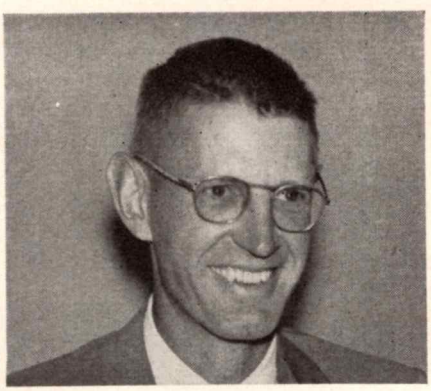
The new device, called a preload indicating or "PLI" washer, eliminates the need for torque wrenches. It consists of two concentric steel rings. The inner ring, which is thicker than the outer ring, takes the load when the nut is tightened, allowing the outer ring to move freely.

Continued tightening of the nut compresses the inner ring until the rings bind. When the outer ring can no longer be moved, the desired preload has been reached.

The ancient metal craft of spinning is the basis for a new metal-working technique used to make jet engine parts, third-prize winner in September.

Called flow-turning, it is the cold-flowing of metal to a desired shape over a hardened mandrel. It offers faster, more precise results than theretofore had been obtained by extensive and costly machining operations.

A. J. Detrie and P. J. Stayboldt shown here holding their Light-Weight Sealant Gun which won them second prize



Pastushin Aviation Corporation's Edward J. Horkey accepted third prize check in recognition of company's system for forcible ejection of fuel tanks and other external stores

In flow-turning, the flat metal sheet or the roughly finished disc forging is held against the mandrel pattern by a hydraulic ram. In operation, the part and mandrel are whirled at a controlled speed. By exerting great force with a separately operated roller, the metal readily takes the shape of the mandrel.

In spinning, the metal is folded back against the mandrel. In flow-turning, the blank diameter is exactly that of the finished part.

Flow-turned parts have greater tensile strength and even after stress-relieving processes, they are considerably stronger than the machined counterpart. In flow-turned metal the grain is always in the same direction.

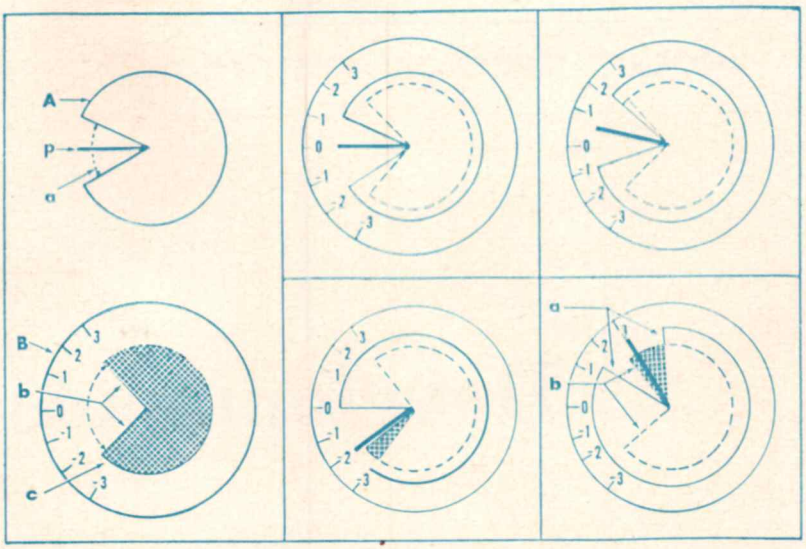
The theory of flow-turning has been known for about 25 years, but it was generally held to be impractical. Arthur A. Merry, Pratt & Whitney chief of advanced tool engineering, now proves it to be a precise technique for working metals in the jet age.

First Prize • $250.00

"A QUALITATIVE INSTRUMENT FACE"

Martin I. Kurke

106-G Garden Drive
Aberdeen, Md.

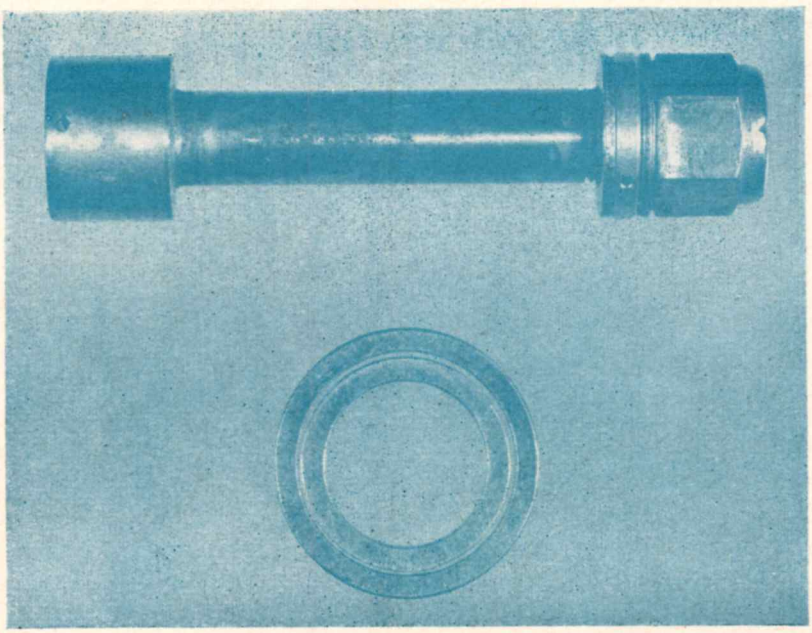


Second Prize • $125.00

"NEW WASHER"

J. L. Waisman

Assistant Chief Metallurgist
Materials and Processes Department
Douglas Aircraft Company, Inc.
Santa Monica, Calif.

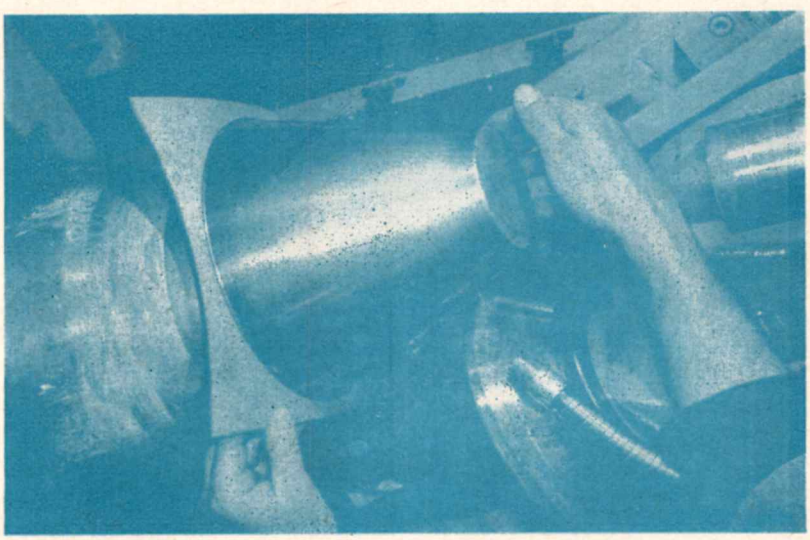


Third Prize • $100.00

"JET ENGINE METALWORKING TECHNIQUE"

Arthur A. Merry

Chief of Advanced Tool Engineering
Pratt & Whitney Aircraft
Division of United Aircraft Corporation
East Hartford, Conn.



Developments in Aircraft Electrical Power

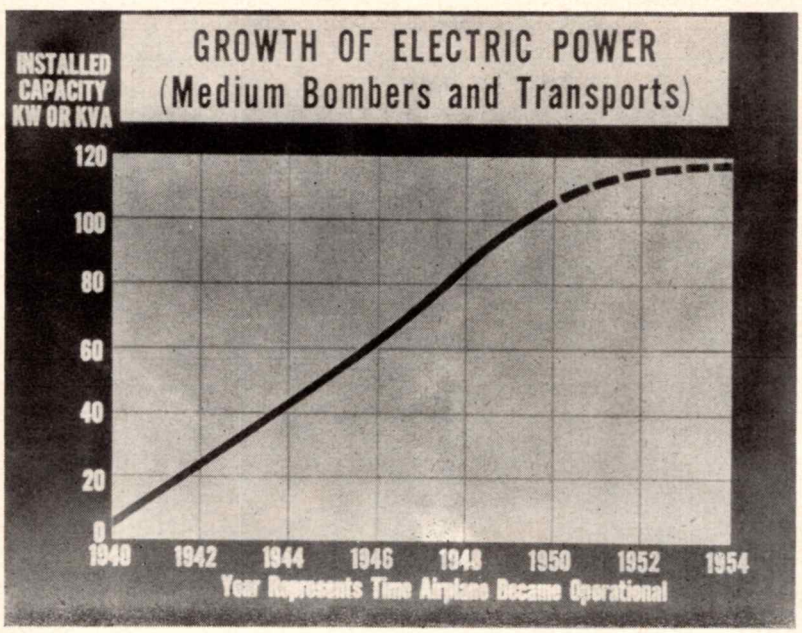
By G. A. PHILLIPS
Aviation Engineering,
General Electric Co.

New design principles solving increasing power, distribution and cooling problems

B-47 Electric-powered tail turret

THE airplane of today is dependent upon electric power. No longer can the electric system be considered as a minor system used to charge batteries for lighting and radio. Today it is all-important as the nerve system and the sinews to perform functions, which with the advent of near-sonic and supersonic planes, can no longer be performed manually by the pilot or the crew. In addition, the functions of navigation, communication, offense, and defense will usually not be possible without the supply of adequate electric power. Many new aircraft when flying under instrument conditions either cannot maintain control when the generating system is lost, or have less than one-half hour operation on the battery before control is lost. In other words, the modern airplane may not even be able to return and land safely without electric power.

This dependence on electricity has come about primarily because of the increasing number of functions for which this type of power is either essential or best adapted. Among the hundreds of items of electrical equipment found on a large airplane there may be in excess of 100 electric motors as on the B-36. The extended use of electricity on aircraft got its first big impetus during World War II. From a few kilowatts in 1940, the aircraft electric system had grown



by 1950 to over 100 kw installed capacity on medium bombers. This trend is illustrated in Fig. 1. It will be noted that as we are approaching the all electric airplane, there is a tendency (since 1950) for the rapid growth to level off. This is due, no doubt, to recent trends in the industry toward simplification and limitation in aircraft physical size. It is true that the installed capacity on very heavy bomber, such as the B-36 and the B-52, is in the neighborhood of twice the figure shown on this curve. Again, however, it would appear that for aircraft of this type there is some tendency towards saturation in the use of electric power.

Medium bombers, as represented by the Douglas B-66, have in the neighborhood of 90 to 120 kva showing good agreement with the curve of Fig. 1. The Douglas DC-7, however, is somewhat below the curve, this being typical of the present-day large commercial transport. There has been no major electric power increase in this category since 1948 with the advent of the Boeing *Stratocruiser*. Our studies show that the first U.S. jet transport, however, will undoubtedly have 120 kva or greater capacity, placing it up with the medium bombers again.

Possibly of greatest interest are the figures for fighter aircraft. One of the new long range escort fighters approaches the commercial transport in utilization of electric power for the many functions which must be performed. Even the smaller fighters, such as the McDonnell F3H and the Lockheed F-94C, use large amounts of electricity. It is interesting to note that in the case of the F-94C, 30 kva is required for de-icing, a function not generally performed electrically at the present time. Further development in techniques for electric de-icing and in the means of applying heating elements to the surfaces may well lead to another large increase in electric power demand on other types of aircraft.

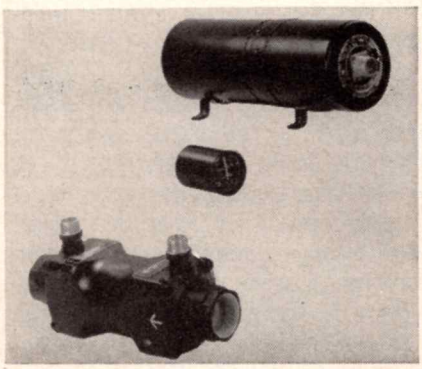
Electric Loads

Electric power is used on aircraft to increase performance, economy, safety, comfort, and military effectiveness. The number of individual functions performed by electricity to accomplish these objectives has steadily increased over the years and has now become too extensive to mention in detail. However, the scope can be visualized by the following categories, each of which contains a large number of individual items:

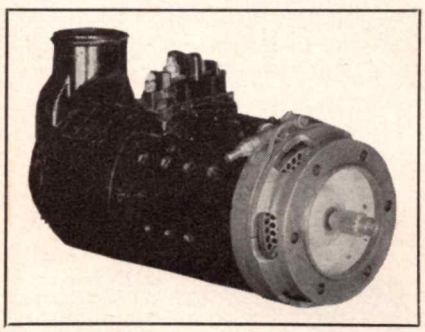
Lighting, instruments, actuators, control systems, pumps and blowers, heating, communication and navigation, offensive and defensive armament, and flight control systems.

In addition to the total electrical demand represented by all these loads, it will be necessary to examine them for the type of power to which they are best suited in order to understand the present trends in electric power systems. With the possible exception of a few of the actuators and some control and warning systems, constant frequency ac power is the logical choice. While it is true that many individual items of equipment currently in production are designed to operate on the old 28-v dc system, most of the newer designs require 400 cycles ac. Also, communication equipment requires 400 cycle ac power and radar uses relatively large amounts of ac, which may be either variable or constant frequency. One of the largest areas of load growth has been in this field of electronics.

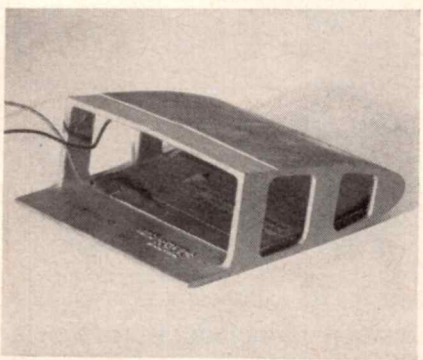
Motors, of course, have become one of the largest loads on those aircraft where nearly all functions are performed electrically. However, practices still vary widely among the airframe manufacturers in this regard, many using hydraulics for actuation of flaps, gear, and similar services. Therefore, the amount of motor load on various aircraft in the same category shows much variation. While it is true that dc motors of the same weight are capable of higher starting torques than ac motors, the latter by proper design and application may be used for virtually all aircraft needs except where closely controlled variable speed is required. However, many of these variable speed applications, such as turret drives, have a variable voltage control which employs a motor-amplidyne or other means of power conversion which is actually better suited to an ac power supply than to dc. AC induction motor drives are preferred wherever possible because of their simple and rugged construction with no brushes and lower maintenance.



Fuel flow system components



G-E aircraft D-C generator model



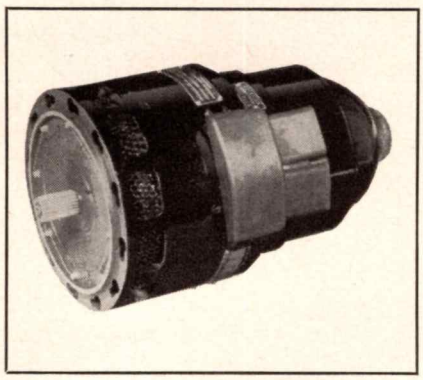
Heater-lip assembly, forward alternators; products on this and following four pages made by General-Electric.

Trend to AC

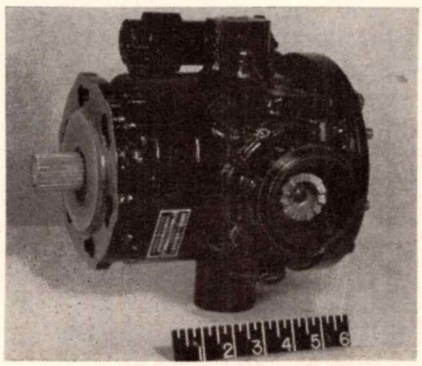
The increasing use of alternating current is a dominant factor in the industry today. One of the principal reasons for this may be found in a study of the load equipment going on these airplanes. The pre-

ceding discussion of electric loads shows how well adapted alternating current is to the needs of aircraft systems. There is no doubt that this is the most significant element in the present trend to ac power generation. However, it is interesting to see how this trend has developed, why aircraft are configured as they are today as to power generation, and where the trend is leading.

Prior to World War II electric power was commonly supplied at 12-v dc with a battery forming a substantial part of the system capacity. With the increase in power requirements around 1940 it was clear that prohibitive weight penalties would result from the distribution of power at this low voltage.



Aircraft generator



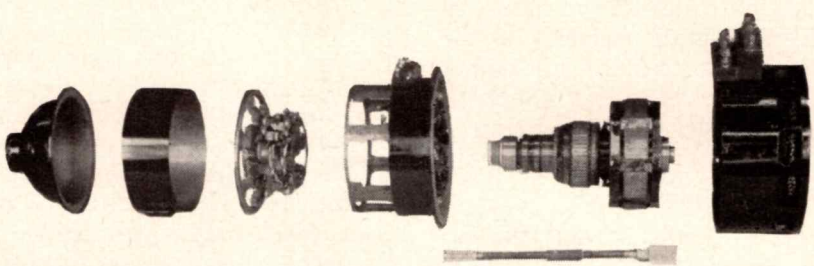
Constant-speed hydraulic transmission

Experimental work had been sponsored by the military services on several systems including ac prior to 1940. However, with the demand for a rapid build-up in production required with the beginning of World War II, the best immediate solution was the widespread use of the 28-v dc system. Many loads have been developed for this type of power and it was relatively easy to convert others. Also, many of the older 12-v. dc aircraft could be easily modified to take the new 28-v. equipment. The writer had the experience during the war in the Southwest Pacific of converting a number of 12-v. C-47 aircraft to 28-v. This modification was developed in the field towards the end of the war primarily because of the increasing difficulty in obtaining spare parts for the 12-v. systems and equipment.

Through 1950, with few exceptions, 28-v. dc provided the bulk of aircraft electric power. This was supplemented in many cases by direct engine-driven, variable-frequency ac generators rated up to 30 kva. These machines provided power of a type which could be directly used by heating equipment such as propeller de-icing, or by electronic equipment such as radar. Furthermore, since the 28-v. dc generators were limited to 12 kw output, it was possible to increase the generating capacity on the limited number of available pads provided on most engines. However, one of the disadvantages with this arrangement was the fact that increasing amounts of constant frequency 400 cps power was also required. This power has always been supplied in small amounts from the 28-v. dc system through inverters which are nothing more than dc to ac motor generator sets. By 1950 a number of aircraft required two or more inverters rated at 2.5 kva each. This represented a large weight penalty as well as a demand for more dc capacity, since the inverters are approximately 50 percent efficient. In addition, it is readily apparent that the airplane had become quite complex electrically, since there were now at least three separate types of power distribution i.e., 28-v. dc, variable frequency ac, and 400 cycles constant frequency ac.

Because of the increasing weight penalties associated with distribution at 28-v., 120-v. dc systems were considered with favor by many people in the industry during the period 1947-1949, and the development of generating equipment was sponsored by the Air Force. However, this system was not accepted for a number of reasons, most important being the preponderance of ac loads and the continued need for inefficient inverters to supply the needed constant frequency 400 cycle power.

Following closely on the 120-v. dc developments just prior to 1950 were other factors pushing the industry toward ac. Reasonable success with the secondary variable frequency system was significant, but the foremost factor was the availability of several types of constant speed drives. The Sundstrand variable-ratio hydraulic transmission had achieved a satisfactory degree of serviceability on the B-36. Turboprop engines operating over a narrow range of speed provided means of getting substantially constant frequency from a direct engine drive. Turbine drives were made possible by use of the compressed air available from bleeding a jet engine compressor. These favorable factors and the Korean War led in 1951 to an accelerated development program undertaken by General Electric for the Navy of improved ac generators and voltage regulators. These were built to a new experimental specification prepared by the Bureau of Aeronau-



Disassembled aircraft A-C generator

tics which was later to become MIL-G-6099, the present ac generator standard for all military aircraft. Control and protective system developments for both single generator and parallel system were also undertaken by the manufacturers. The availability of these new drives, generators, and control, coupled with the increasing ac load demand, has led in the last two years to the application of ac power generation to all present day aircraft.

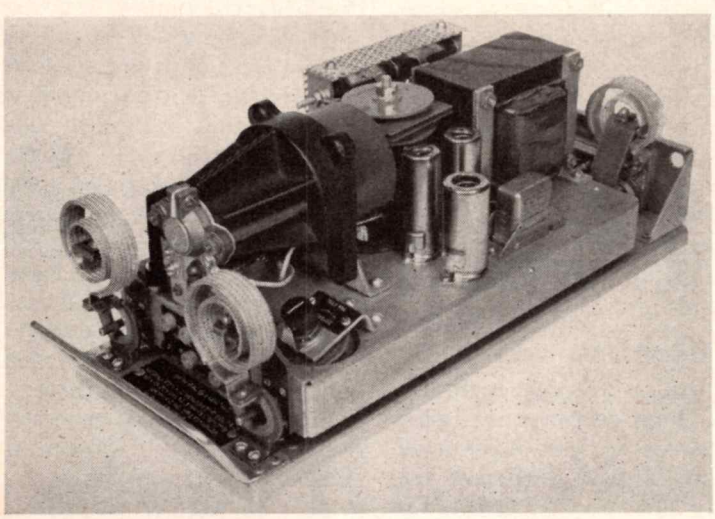
One of the most popular current combinations for small and medium aircraft is what we might call the two-system airplane, employing both 28-v. dc and constant frequency ac power generation. By the addition of the constant frequency generators it has been possible even with the additional drive weight to achieve an actual weight saving by replacement of the inverters and variable frequency generators along with a reduction in the dc capacity resulting from elimination of the inverter load. By providing an adequate supply of constant frequency ac it is possible to use induction motors with a further weight reduction and increase in reliability for many loads. As the dc load is reduced, it becomes economical in some cases to eliminate the dc generators entirely and supply 28-v. dc power by means of transformer-rectifier units operated from the ac system. These small and medium sized aircraft thus are beginning to approach the all ac system as originally developed during World War II for the B-36 and recently applied to the other very heavy bomber, the B-52. I fully expect to see the first commercial jet transport built in this country provided with all ac electric power generation.

Generators

Although the application of ac power is increasing very rapidly, there are still a considerable number of aircraft going into production which require dc generators. Due to the higher power requirements on both military and commercial transport aircraft, it has been necessary for the dc generator designers to keep pace by improving the output within the same weight and space envelope. As an example, the General Electric Model 2CM244A2 machine shown in Fig. 6 has been put in service on the Douglas DC-7.

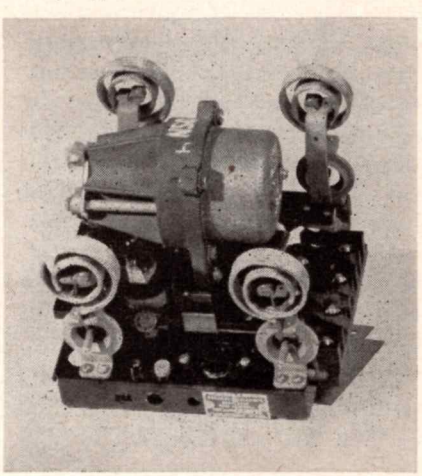
This generator incorporates a number of new design features which increase the output, improve the reliability, and reduce the operating cost. Due primarily to the addition of the Freon cooling system on the DC-7, its load was increased appreciably over that of the DC-6B. This resulted in the need for a generator with good base speed characteristics capable of delivering 250 amp at 3100 rpm with one in. of water pressure drop for one-half hour during ground and taxi operation. It also required a generator capable of delivering 400 amp for intermittent periods up to 10 hours during take-off, climb, and cruise. The heating in the commutating and compensating winding was reduced by the use of a single circuit of rectangular formed bar copper rather than the four-parallel circuits of round insulated wire used previously. By use of the shrink ring commutator the ability of the commutator to withstand higher temperatures and higher speeds without deformation has been increased. A newly developed General Electric brush suitable for both sea level and high altitude operation was also used as it permitted high loads without increase in temperature. Furthermore, this new brush has the desirable characteristic of being able to operate at altitude without a prolonged run-in at sea level to produce the commutator film necessary with older types of altitude treated brushes. Thus it was possible to produce a generator with very little increase in weight and overhung moment over the earlier 300 amp rated machines yet capable of meeting the more severe requirements of the DC-7. Among the several improved mechanical features found on the new dc generator are the quick-attach-detach mechanism which eliminates the need for removing the nuts on the mounting studs which were very inaccessible in this installation.

All generator manufacturers have concentrated a great deal of effort on the design of ac generators for the many new applications which are steadily increasing



A-C generator voltage regulator

Regulator on center of gravity type voltage regulator on center-of-gravity type aircraft vibration mount

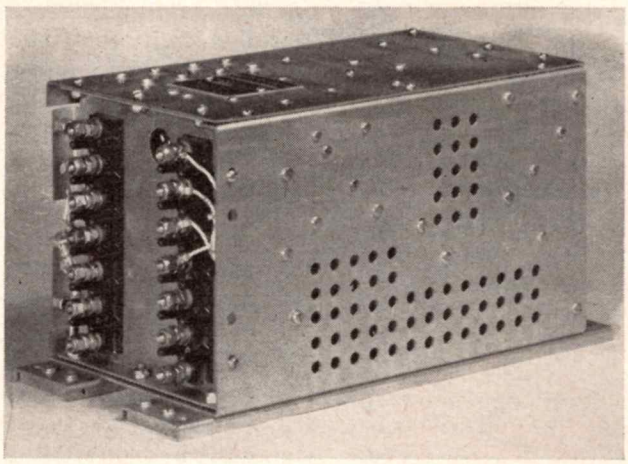


in number. Typical of these machines is the General Electric machine built in an 11-in. frame dia., characteristic of a complete line of ratings from 15 kva to 90 kva. Most recent developments in this line are 20, 30, 40, and 60 kva, 5700/6300 rpm, 400 cycle, 208/120 v, .75 power factor, suitable for use from sea level to 65,000 ft. altitude. At sea level the machines are capable of operating at full load with 80 deg. C. inlet air temperature and six inches of water pressure drop.

Since some loads require good wave form, harmonic suppression has been accomplished by optimum pitch and distribution as well as skew in the stator. The third harmonic is non-existent for balanced loads from no-load to 200 percent load. No harmonic exceeds one percent over the rated speed range.

Transient response is good with a recovery time to normal voltage after applying or removing full load less than 0.15 sec. Since machines must operate in parallel and may also be subjected to severe transients due to synchronizing and short circuits, they have been designed with extremely low resistance amortisseur circuits. This means that when heavy loads are applied or removed, when system faults occur, or when synchronizing is accomplished, mechanical oscillation of the rotor is reduced and electrical transients are damped quickly. This also increases the stability of the governing systems of the constant speed drives when machines are operated in parallel.

The rotor construction on these ac machines requires careful consideration of a number of conflicting factors. In order to achieve maximum stiffness, the rotor punchings are stacked on a hollow steel outer shaft without the use of spiders to support the laminations. This also reduces possible fire hazard since electrical failure in the machine or a bearing failure will not result in mechanical disintegration of the rotor due to collapse of light weight spiders. It will be noted from the exploded view that the weight is concentrated near the mounting flange end in order to reduce the overhung moment and increase the generator natural frequency. A dc exciter is mounted on the same shaft in order to provide the field excitation for the ac machine. The slip rings are located adjacent to the commutator on the outboard end so that all brushes are accessible under one brush inspection band.



Aircraft static voltage regulator

The blast cooling air is introduced through the opening in the blast cap and passes through the ac field after passing over the exciter. On some models a fan is provided which induces enough air flow during ground operation when no blast air is available to enable the machine to deliver full output. A serious cooling problem has existed on earlier ac machines due to the tendency of the rotor to run hotter at altitude than at sea level. The altitude rating has been improved by reducing heating losses in the field and by careful design of air passages through the rotor which actually induce increased cooling air flow. As a result, it has been possible to obtain full output on a 60 kva machine both at sea level with 80 deg. C inlet air and six inches pressure drop and at 60,000 ft. altitude and zero deg. C with 10 in. of water pressure drop. Generators with this performance are generally suitable for airplanes having high subsonic or low-supersonic speeds.

Generator Controls

As in the case of dc generators, continual improvements are being made in dc generator control equipment. Fig. 9 illustrates the latest type of voltage regulator for 28-v dc generators. The regulator itself is a plug-in unit weighing less than three lb. which, together with the vibration mount, weighs less than five lb. It is required to dissipate 90 watts and operate over a resistance range of 1.25 ohms to 35 ohms while meeting the severe performance and environmental requirements of MIL-R-6809.

One of the most interesting features of the regulator is the center of gravity type vibration mount designed specifically for the carbon pile regulator, but also readily adaptable to other types of control equipment. It is unique in that it permits the protected device to be mounted in any plane and isolated from vibration in any direction. In addition, the design was required to transmit less than one g vibration when subjected to 0.060 in. total excursion from 10 to 60 cycles and 10g equivalent displacement from 60 to 200 cycles.

AC generators of aircraft design require several hundred watts of dc power for field excitation which is customarily supplied through slip rings on the rotor. While this power could be supplied from the separate dc system on airplanes which have one, it is considered better practice not to have the systems interdependent. Therefore, modern ac generator designs employ a small dc generator on the same shaft for this purpose. The ac output voltage is regulated by controlling the field current of this exciter.

The ac voltage regulator has employed the carbon pile principle

for a number of years. One of the most advanced regulators of this type is illustrated in Fig. 10. The carbon pile unit itself is readily recognizable, but additional features which have been added are an ac sensing circuit, an accurate glow tube voltage reference, an electronic trim circuit, and a stabilizing transformer. Greatly improved voltage regulation over that of the basic carbon pile is obtained by the electronic trim feature operating against a reference which is much more accurate than the spring and solenoid of the carbon pile. The design is such that a failure of the trim circuit does not cause failure of the regulator, but simply gives the somewhat poorer voltage regulation of the carbon pile.

Although the carbon pile regulator has given a good account of itself in both dc and ac aircraft systems, it has several disadvantages among which are: short life due to wear of the carbon pile, difficulty in providing good temperature compensation, and effect of linear acceleration on the stability and regulated voltage. Therefore, at the time the General Electric Company undertook to develop improved ac generators and regulators for the Bureau of Aeronautics, it was decided to go to a static magnetic amplifier type of regulator which would eliminate these problems and give in excess of 5000 hr. life without maintenance. The ac output voltage is compared with an accurate voltage reference and the error signal fed into a two-stage magnetic amplifier which supplies the exciter field current. The original regulator developed for the Navy used a bias field in addition to the main exciter boost field since it was necessary to operate with variable frequency generators. The bias field provides stable operation over a wide range of main field current.

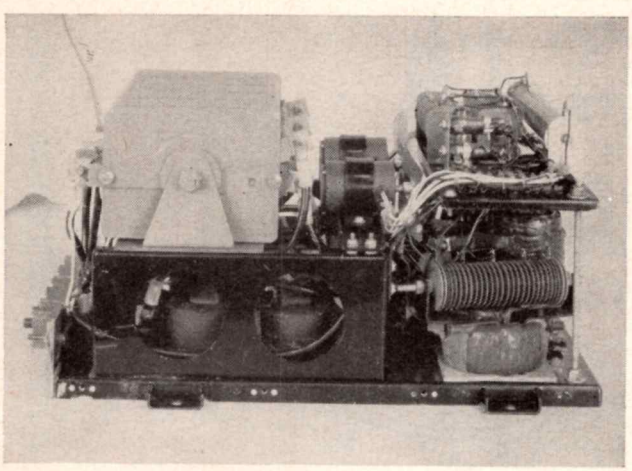
The latest development in static regulators is illustrated in Fig. 11. This regulator has been developed for the Air Force and will be used on the Douglas B-66 as well as on other advanced types of Air Force planes. The principle of operation is the same except that no bias field is required, since the regulator has to operate only with constant frequency generators.

This new regulator represents an important advancement since its long life eliminates the need for the plug-in feature used on the carbon pile to facilitate maintenance. Furthermore, the use of static components permits the regulator to be bolted directly to the airplane structure without the use of vibration mounts thereby saving considerable space and weight. These regulators must also make provision for parallel operation of ac generators by dividing reactive loads equally among machines.

In order to provide power to the airplane electric system with convenince, safety, and reliability, the power must be controlled by suitable switching and the generator and power system adequately protected. A great deal of progress in the control and protective functions to be applied to both single and multiple ac generator installations has been made in the past year. Switching has been made completely automatic so that in a twin-engine airplane all the pilot has to do is start the engines. Generators come on the line and parallel automatically, also disconnecting the source of ground power. Depending on the requirements of a particular application, protection may be provided for any of the following conditions, selectively removing and de-energizing the faulty generator if operating in parallel: Short circuits, over or under voltage, over or under excitation, open phases, under speed or under frequency, or reversed phase sequence.

These control and protective functions together with a source of dc control power, usually a small transformer-rectifier, are often grouped on a single control panel. This particular panel is designed for parallel system operation and is of drawout construction to be mounted on a rack in the airplane. Other similar units are designed to be bolted directly into the airplane and there are also installations where, due to limitations of space, it is desirable to mount various components separately.

As mentioned earlier, it has been found very desirable in a number of airplanes to supply 28-v dc power from the ac system rather than have a separate dc generating system. This is customarily accomplished by the use of a transformer-rectifier through which the voltage is reduced to the desired level and rectified by means of selenium rectifier stacks. These units have been built in both regulated and unregulated versions and in ratings from a few amperes up to the 200 amp regulated unit illustrated in Fig. 12. Typical weights are 17.5 lb. for a 50 amp unregulated unit, and 70 lb. for a 200 amp regulated unit.



G-E regulated airborne transformer-rectifier

There will undoubtedly continue to be a need for transformer-rectifiers to supply 28-v dc power as more and more aircraft are built with only ac power generation. It is to be expected, however, that the amount of low voltage dc needed will steadily decrease as more and more load equipment is designed for ac operation.

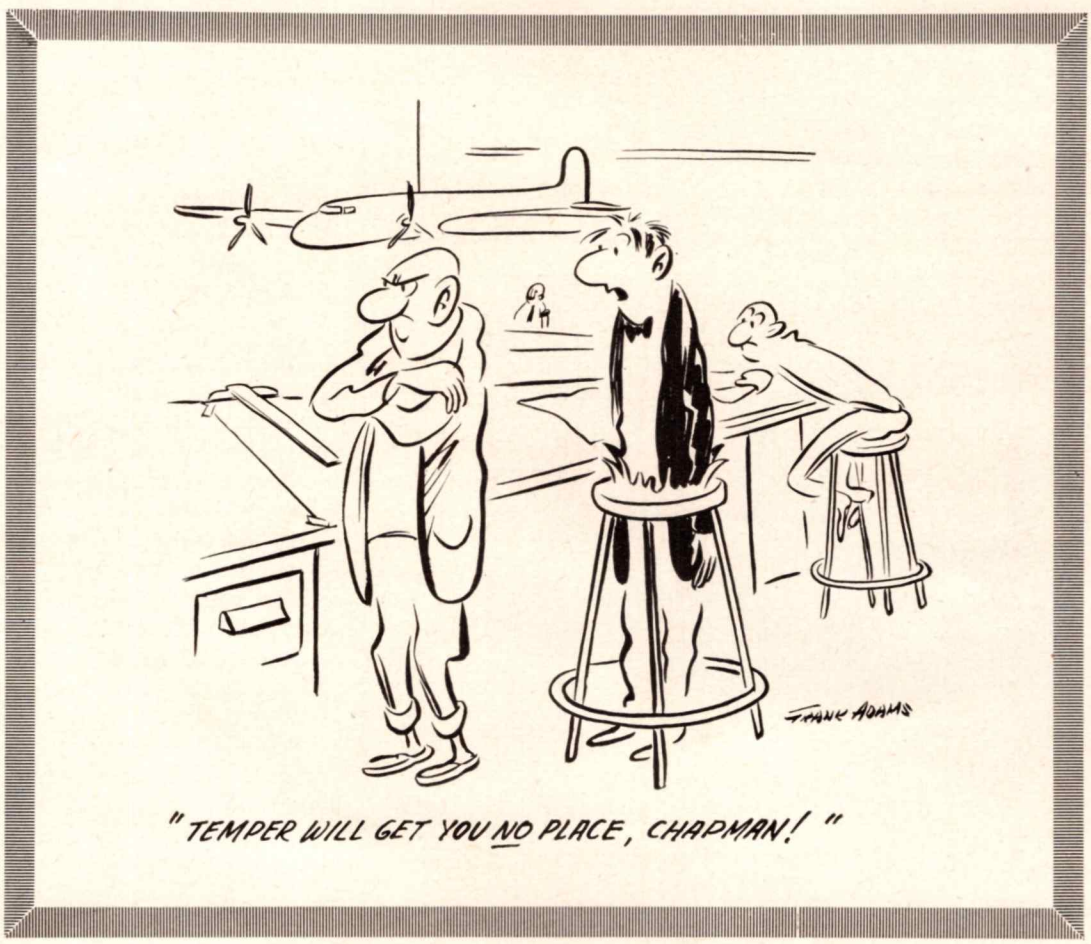
Both dc and ac generators are now being made available which can operate successfully with cooling air temperatures greatly in excess of the 80°C. mentioned earlier. This is being accomplished by the use of higher temperature insulating materials, improved electromagnetic design for minimum losses, and refinement in air passages and heat transfer techniques. Studies are also showing that it will be economical to use oil for generator cooling since oil is already used for cooling and lubrication in the engine and in both the hydraulic and turbine type constant speed drives. Generator manufacturers have already built and successfully tested, both dc and ac oil cooled machines. Such environment-free machines remove the limitation of the high temperature, low density cooling air from the generator installation although, of course, it is necessary for the airplane manufacturer to provide means of disposing of the heat transferred to the oil. However, this problem is already present and by combining the cooling functions for more than one piece of equipment, better overall performance is often possible.

Weight reductions are being accomplished by investigation of higher rotational speeds and by refinement of electromagnetic and mechanical design. For small aircraft in the fighter category, General Electric has developed a line of 7-in. frame diameter ac generators in a range of ratings from 5 kva to 20 kva. These machines have either an integral exciter or if needed, can be provided with an external static excitation system, in order to reduce weight and space in the type engine installations created by the demand for smaller frontal area.

In the area of control equipment, relays, capacitors, rectifiers, transformers, and reactors are available for ambient temperatures in excess of 120 deg. C. To minimize the environmental problem, particularly altitude, many types of relays and other components have been hermetically sealed. By miniaturization of components and improved manufacturing and assembly methods, both space and weight are being steadily reduced.

As the needs of aircraft for more and more electrical equipment with improved performance have faced the electrical equipment manufacturers, solutions to the design problems have been and are being found. The many types of load equipment now required in aircraft in order to accomplish its intended purpose are dictating a rapidly increasing use of 400 cycle 3-phase ac power. Equipment is currently available for supplying this type of power on all types of airplanes and its capability for operating on higher performance planes is being steadily improved.

END



"TEMPER WILL GET YOU NO PLACE, CHAPMAN!"

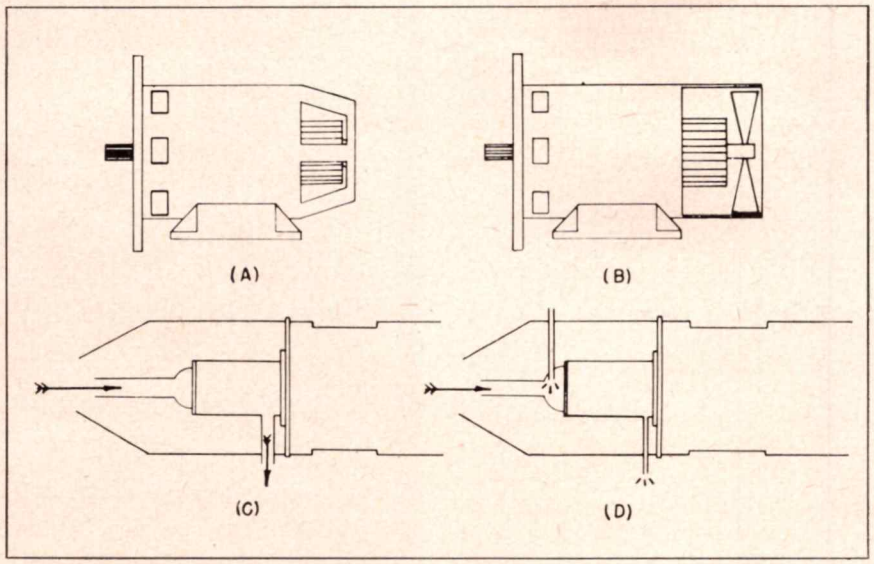


Fig. 1 Techniques for cooling open-ventilated electrical accessories. (A) Self-cooling technique, where convection and radiation are sole means of removing heat; (B) Similar to (A) except that fan forces convection and promotes better cooling; (C) Blast-cooling with air stream passing through machine; (D) Similar to (C), but with water-injection added

AIRCRAFT ELECTRICAL SYSTEMS

Cooling Techniques for Airborne Equipment

By CECIL MARTIN
Design Engineer, Jack & Heintz Corp.

STEADILY rising upper limits of altitude and speed have made the dissipation of heat a very high priority problem among accessory designers. A few years ago, the range of ambient temperatures to deal with was on the order of zero to 80 deg. F. Today, that range is from −80 to 260 deg. F. In addition, there is considerably greater array of electrical equipment aboard aircraft, which greatly complicates the problem of cooling.

Presently, three cooling techniques are enjoying the widest use. They are: air-cooling, liquid-cooling, and evaporative-cooling. There is also the somewhat special thermal lag approach being made practical by missile work.

Air-Cooling Methods

Basically, there are three broad categories of air-cooling methods: (1) open-ventilated, (2) totally-enclosed, and (3) bleed-air.

Typical open-ventilated techniques are shown in Fig. 1.

Technique 1A relies solely on the dissipation of heat from the frame by means of radiation and free convection. This method is not particularly suited for modern aircraft because of a very poor

Analysis of available cooling methods indicates steam system superior

Fig. 2 Chart showing weight of air that can be handled by fan, and blast air cooling techniques at altitudes

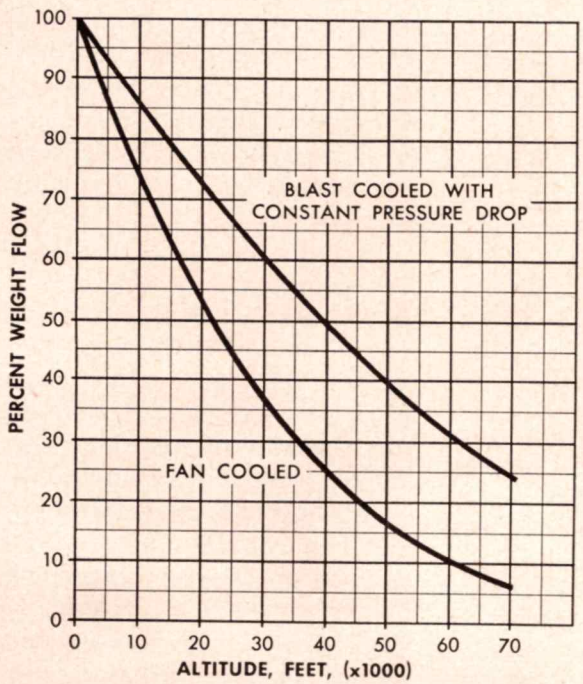
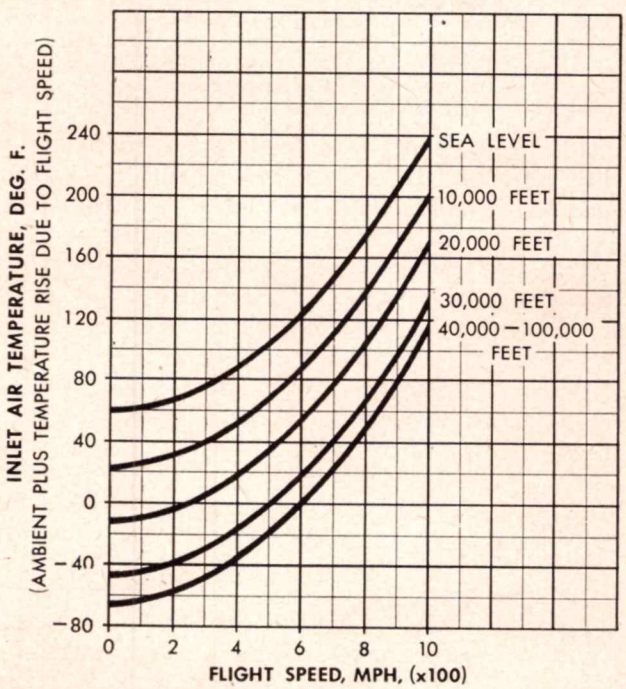


Fig. 3 Chart illustrating the altitude effect on inlet air temperatures from sea-level to 40,000-100,000 feet



cooling efficiency which results in a high accessory weight for any given rating. There is also a high fire hazard inherent to this type of cooling.

Techniques 1B (fan cooled) and 1C (blast cooled) are similar to each other. They are rather widely used at the present time, relying on a fast-moving air stream and accompanying pressure drop to effect cooling. While popular, these techniques are due to be seen less frequently as aircraft design advances. At high altitudes, the quantity of cooling air that can be put through these machines is considerably reduced as shown in Fig. 2. Consequently, the effectiveness of air as a heat remover drops rapidly. Also, flight at high speed causes a rise in cooling air inlet temperatures (Fig. 3) which, in extreme cases, might eliminate any possibility of using conventional blast systems. In fact, flight speeds of 1000 mph would lead to quite severe temperature conditions for equipment built to present fan-cooled or blast-cooled specifications.

Technique 1D is basically the same as technique 1C with the exception of water-injection. While it is true that water injection lowers the air temperatures encountered in high-speed flight and thereby reduces machine operating temperatures, this type of system does not make good use of water and drag loss is very high. The heat transfer coefficients are not changed appreciably; the quantity of water and temperature drop of the air would tend to be limited by the 100 percent relative humidity or less condition; and control to assure 100 percent relative humidity or less along with safe temperature limits is very difficult.

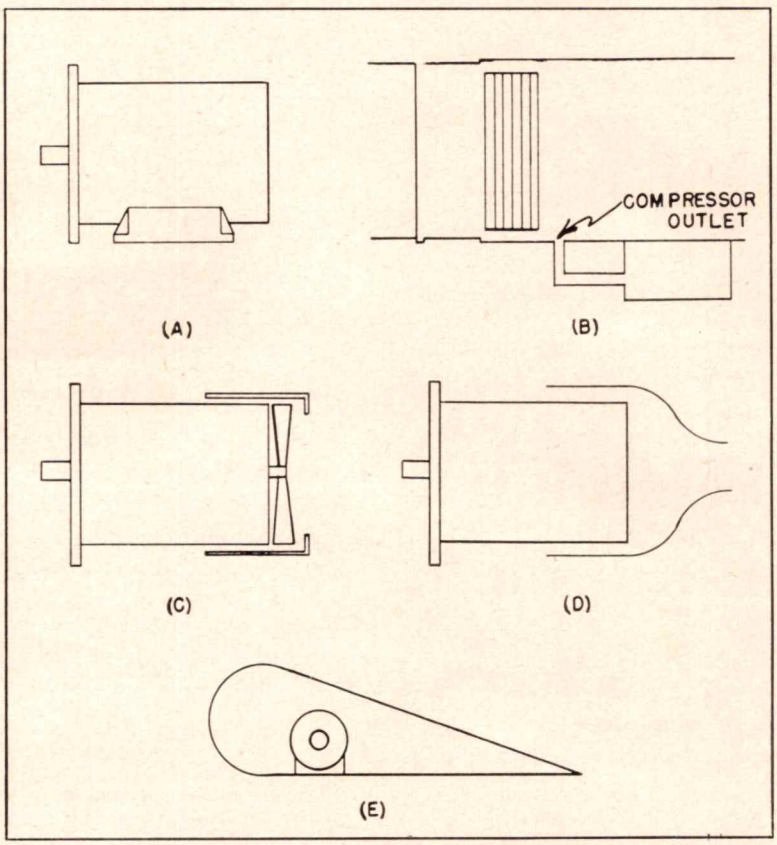


Fig. 4 Principal techniques for cooling totally-inclosed electrical accessories. (A) Self-cooled, relying solely on convection and radiation. (B) Same as (A) except that provision is made to pressurize interior of the accessory. This helps to maintain rating. (C) Same as (A) except that fan has been added to force convection. (D) Same as (A) except that blast-air is directed over machine. (E) Same as (A) except that machine has been brought into metal to metal contact with the aircraft wing skin

Typical techniques involving totally-enclosed machines are shown in Fig. 4.

Totally enclosed machines are those in housings which are unventilated. Such machines are employed where explosion-proof conditions must be kept.

Technique 4A promises to continue for small equipment having low loss rates, low power rating or short-cycle intermittent duty service. The rate of heat transfer for a given temperature, under this method, is essentially independent of altitude.

If it is essential to maintain a constant machine rating, technique 4B may be employed. Here you have a totally enclosed machine with special provision for maintaining internal sea level pressures. If pressures greater than sea level are maintained, slightly greater ratings are feasible as compared to the present sea level ratings for this cooling method.

Technique 4C will allow much higher ratings than 4A at low altitudes due to the much greater heat-transfer rate obtainable with forced convection. As the altitude is increased, however, the forced convection falls off and the rating approaches that obtainable by radiation alone. For very high altitudes, therefore, this system is not too practical.

The blast-cooled version, technique 4D, would give the best cooling due to the much higher pressure drops available and the lower losses resulting from eliminating the power-absorbing fan.

Technique 4E involves metal-to-metal contact with the skin of the wing. Such installations can provide considerable extra cooling for small, totally-enclosed machines. It should be kept in mind, however, that this mode of cooling is not free of altitude effects. After being conducted to the airframe, the heat must still be convected to the air where the heat-transfer coefficient drops off at altitude. Further, in the supersonic flight speed range, the temperature of the airplane skin may prohibit high heat transfer rates.

The thermal lag approach involves an intentional absence of a cooling system and is to be considered for missiles only. This method calls for isolating the generating unit from severe environmental temperatures. Improved insulation within the machine permits it to run efficiently for 20 min. or more. Many missiles have flight times considerably shorter in duration. Hence, the "lag" period before thermal effects are felt by the machine is suffi-

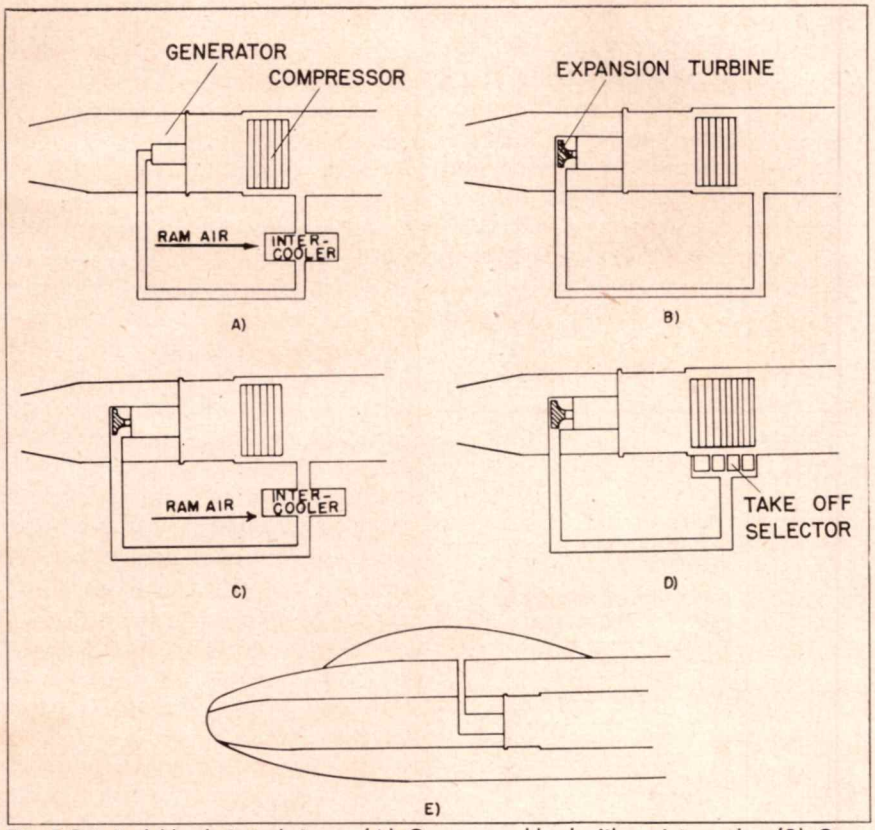


Fig. 5 Principal bleed-air techniques. (A) Compressor bleed with an intercooler. (B) Compressor bleed with an expansion turbine. (C) Compressor bleed, intercooler and expansion turbine. (D) Compressor bleed, expansion turbine and selective pressure takeoff. (E) Cabine bleed

ciently long to permit operation of the machine during the entire flight of the missile.

There is a possibility that missile flight durations may eventually prohibit resorting to thermal lag. In this case, evaporative cooling techniques, discussed later, may be the answer.

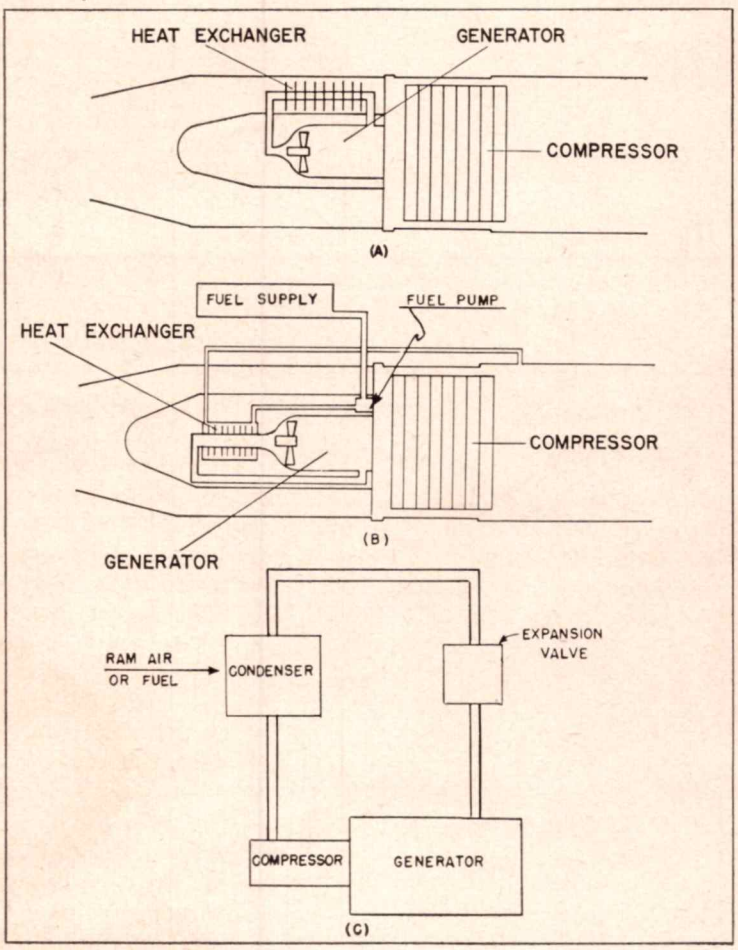
Open-ventilated and totally-enclosed air-cooling methods are bound rather closely to altitude effects. Attempts to give air-cooling more environment-free character are seen in the bleed-air techniques, Fig. 5.

Technique 5A bleeds air from the compressor and passes it through an intercooler which is fanned by blast air. The penalties (temperature limits, plumbing, controls) involved with this system appear to be quite severe, and, in comparison, the larger, better-cooled and more efficient blast-cooling methods of Fig. 1 appear to have greater long range possibilities.

Techniques 5B, 5C and 5D involve compressor bleed passing through an expansion turbine. Air is taken from the compressor exit, pulled through the expansion turbine and directed over the machine to be cooled. The expansion turbine drives the accessory. This method has possibilities. However, for normal pressure ratios and flight speeds of jet engines, the compressor outlet temperatures may still be too high for effective cooling after leaving the expansion turbine. This may be overcome by the technique shown in 5C, where a heat exchanger is placed ahead of the expansion turbine.

The overall efficiency of air-turbine installations utilizing air taken from the compressor exit is very low because the turbine must be designed for the pressures available at the engine idle condition. This condition may be eliminated to a large extent by using a selective compressor takeoff control as shown in 5D. In this case, air is bled off the compressor exit during idle and then, progressively,

Fig. 6 Principal liquid-cool configurations. (A) Recirculating liquid or high-pressure gas with an air-cooled heat exchanger. (B) Recirculating liquid or high-pressure gas with a fuel-cooled heat exchanger. (C) Mechanical refrigeration system.



from earlier stages of compression as the engine comes to speed. For an installation of this type, the drive efficiency of the air-turbine system approaches that of the conventional gear systems. This system further offers the advantages of constant speed drive and adequate cooling at no extra cost.

Technique 5E utilizes bleed air from the pressurized cabin. While still considered by some designers, this method appears to hold little promise to date. Indications are that the air temperatures are too high, the pressures too low and the quantities of air too small for cooling present generator designs. There is a remote possibility that as flight speeds continue to rise, there may be greater capacities in cabin cooling systems which may eliminate present drawbacks of this technique as applied to accessory cooling.

Generally speaking, it appears as though conventional fan and blast cooling systems will be inadequate for higher-speed higher-altitude aircraft.

It has been common to encounter installations where three distinct cooling requirements are involved:

(1) Ground idle, taxi and take-off; (2) Normal flight throughout a range of speeds and altitudes; and (3) Short duration high-speed and/or high-altitude flight.

Unfortunately, ram air as a heat sink is usually available in large quantities at useful temperatures only during the normal flight conditions. During ground idle and high-speed flight, other heat sinks such as cabin exhaust, fuel, turbine exhaust air or expendable evaporant may be more practical. The utilization of other heat sinks is extremely difficult and often impractical with a basic blast-cooled machine design.

In view of these short-comings of air-cooling systems, much greater attention is being directed to the relatively newer liquid and vapor cooling techniques.

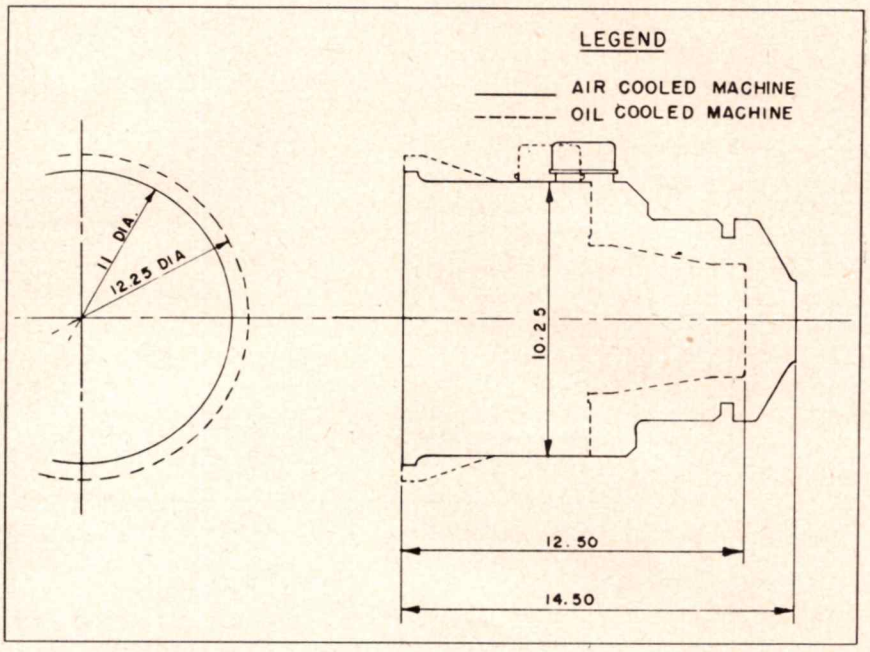
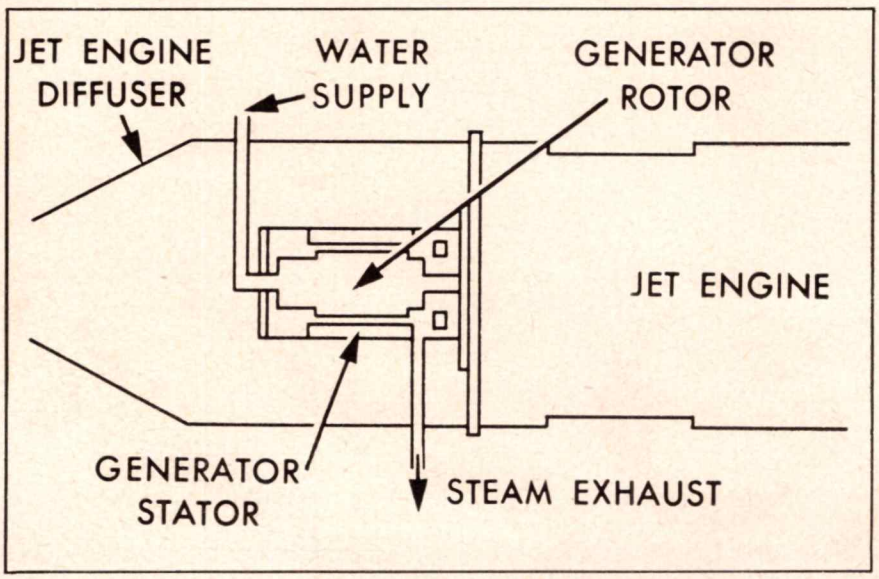


Fig. 7 Comparison of 40 KVA air and oil-cooled alternators

Fig. 8 Representative vapor-cooled system



Liquid-Cooling Methods

Liquid-cooling techniques can take on a number of configurations. Presently, the most prominent of these are: (1) Recirculating liquid or gas with an air-cooled heat exchanger, Fig. 6A, (2) Recirculating liquid or gas with a fuel-cooled heat exchanger, Fig. 6B, and (3) Mechanical refrigeration system, Fig. 6C.

In addition, several other possibilities exist which can be considered such as utilizing a flush skin heat exchanger, deicing system heat exchanger or even a cabin heater.

All of these versions are environment bound to some degree although the mechanical refrigeration system can be designed for almost any given environment.

Systems recirculating liquid with air heat exchanger (Fig. 6A) are environment bound in the same fashion as present blast-cooled systems. This is due to the decrease in available pressure drop and air density at high altitudes which would require a larger, heavier heat exchanger. But despite some penalties, this technique of liquid cooling has many very attractive advantages which will

lead to its wide usage as a cooling system for accessories in advanced aircraft.

Accessories can use the same working fluids as modern turbine engines, gear boxes and constant speed drives. So long as the gear box or engine utilize a lubricant compatible with good heat transfer characteristics, a single cooling circuit is possible employing already available pumps, sumps and external plumbing. The large 3 to 4-inch ducting and still larger shrouds of blast-cooled equipment can be eliminated in favor of ½-inch tubing. Large internal air passages in the generator can be eliminated enabling the machine's diameter and length to be reduced by at least 10 percent, Fig. 7. The congestion of present engine mounting pads can be relieved. The momentum drag normally incurred due to the loss in energy of the ram air as it passes through the ducts and passages of air-cooled machines can be eliminated. A recirculating system can be adapted to reject heat to any available heat sink and to switch from one to another as required. This is a powerful asset under an extreme range of environments encountered by many current aircraft. Brush life can be extended by maintaining a controlled atmosphere around the brushes.

The fuel heat-exchanger technique (Fig. 6B) would tend to require a larger heat exchanger for the sea level engine idle and high-altitude operating conditions since the engine fuel flow rate is reduced considerably at these conditions.

Here, the high heat-transfer coefficients obtainable with liquids would keep the heat exchanger weight very small even for these conditions. Add the advantages listed above to the fact that the fuel flow rates of the modern aircraft are getting very high and you find that this system appears to have very attractive possibilities for extensive application.

Mechanical refrigeration (Fig. 6C) does not appear to be too feasible for most applications because weight of the system tends to be too high, the complexity inherent to these systems adds to the maintenance and life requirement difficulties and space required may not be available on most engines.

Actually, almost all applications where the temperature conditions are severe enough to justify this system can also be cooled by the vapor-cooling technique. However, if a mechanical refrigeration system is necessary for cooling the cabin, fuel or both, the system can be made slightly larger to accommodate the generator.

The cleanliness, compactness, efficiency and other advantages of the liquid-cooled installations predict their becoming a most prominent means of cooling rotating electrical machinery aboard aircraft.

Vapor-Cooling Methods

A vapor-cooling system takes on the general design shown in Fig. 8. A typical aircraft generator designed for vapor-cooling is shown in Fig. 9.

Actually, this technique is similar to the water-injection method reported under the open-ventilated air-cool systems.

However, this system is much more desirable than the latter. The heat transfer coefficients for boiling water are 20 to 200 times that for air. The high heats of vaporization tend to keep the weight of coolant required at a reasonably low value. For flights of short duration, the total weight of required coolant will be much less than the lifting capacity taken away from the plane by blast-cooling. For applications of too short duration or expendable flights such as guided missiles no control is required beyond a simple orifice set to meet full load cooling requirements.

Basically, a vapor-cooled system works as follows: Coolant from the reservoir is injected into the generator's hollow shaft under pressure. Centrifugal force propels the water through the four ports in spray form and scatters it on the internal surfaces of the machine. As it picks up heat from these surfaces, the water vaporizes. Resultant steam escapes through an exhaust port.

Because of the extreme simplicity, excellent cooling efficiency and the fact that the inherent design problems have been largely minimized, vapor-cooling systems offer the greatest promise of environment-free operation. There seems little doubt that these systems will eventually replace blast-cooling methods for short duration flights. END

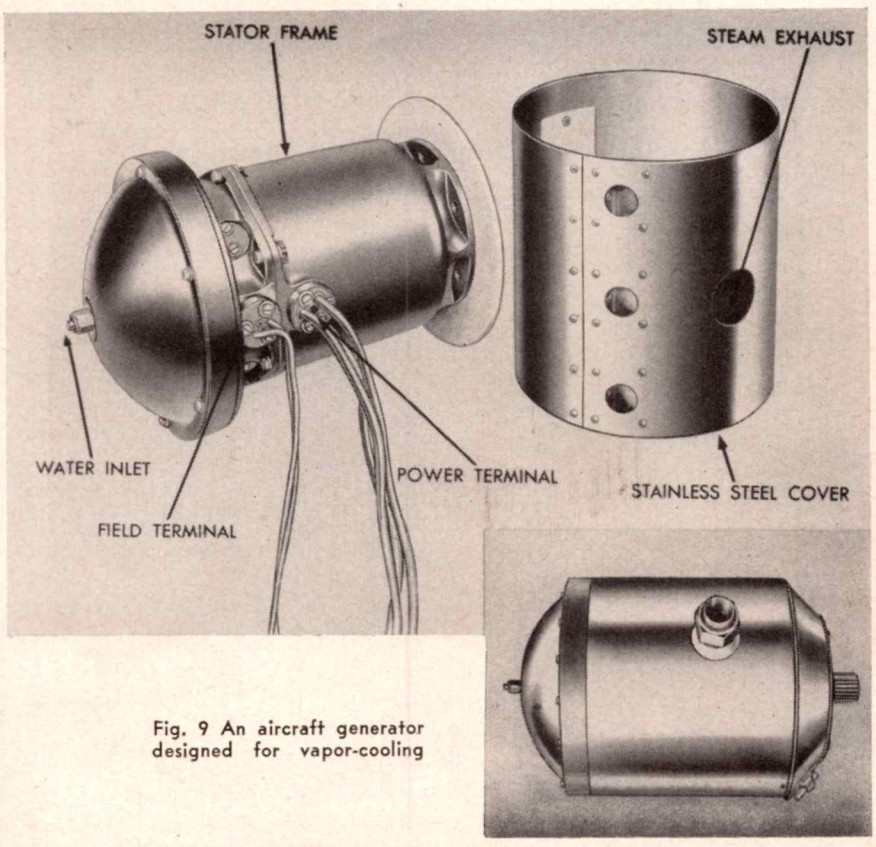


Fig. 9 An aircraft generator designed for vapor-cooling

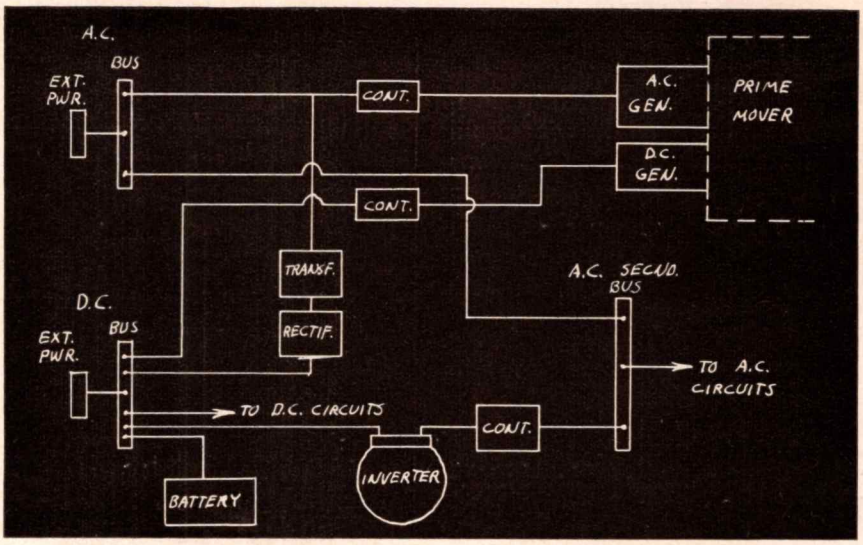


Fig. 1 Typical electric power system schematic

Design of New Electrical

By C. K. McBAINE
Design Engineer
North American Aviation Inc.

New methods developed for weight estimating of projected circuits and equipment

IN the past the weight of the aircraft electrical system has been estimated mainly by statistical methods. These methods (such as percentage of weight empty as obtained from similar aircraft) are completely unreliable because different aircraft rarely have the same electrical load requirements, voltage or environment even though the aircraft may appear similar functionally and in other respects.

The importance of obtaining more accurate weight estimates of the electrical system is becoming more critical as our advanced aircraft are using more electrical and electronic equipment to carry out their intended missions.

Through more logical and accurate weight estimating methods, such as presented here, we are gradually closing the gap that exists between the preliminary weight estimates and the actual weight of the aircraft. This, of course, is an objective of all aircraft manufacturers.

The electrical power system as treated here is defined as the electrical system from the source of electrical power to the functional circuit distribution point. The basic elements of the electrical power system are treated individually in arriving at the total weight of the system. These elements are: (1) Electric power generating units, (2) Electric power conversion units, (3) Electric power control equipment, (4) Electric accumulators, and (5) Electric power transmission lines.

A typical electric power system circuit containing the various elements outlined above is shown in Fig. 1. A sketch of this type of simplified circuitry can be very helpful in preparing the estimate, and is practically mandatory where changes are encountered during design.

Selected Equipment

The selection of equipment for the electrical power system will depend upon the electrical load of the system and the amounts of this load that will be DC or AC current. This requires a rather detailed electrical load analysis which is beyond the scope of this article.

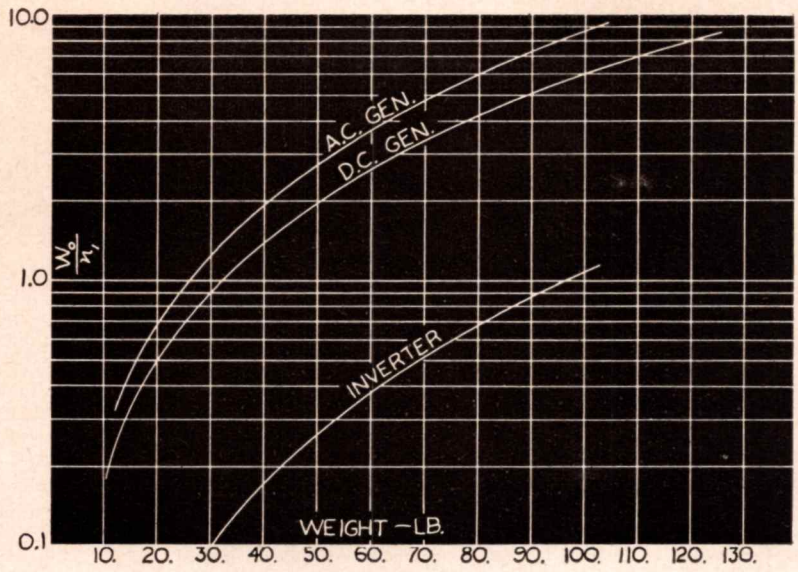


Fig. 2 Power generating plots for various values of Wo/n_1. Also shown is curve of inverter weight

Power Systems

Assuming that the components for the system and their power ratings are determined by the electrical engineer, we can estimate the weight of these various components based on certain design parameters.

Power Generating

D. H. Scott of the Naval Research Laboratory has found that terminal voltage, load current, and minimum rotor speed of generators are design factors effecting their weight. He has plotted generator weight vs power in watts per minimum rotor speed in rpm and has derived an equation for the curve which has the following form.

$$W = K \left(\frac{Wo}{n_1}\right)^a$$

where: W = Generator weight-lb., K = An empirical constant, Wo = Power of generator-watts, n_1 = Generator minimum rotor speed

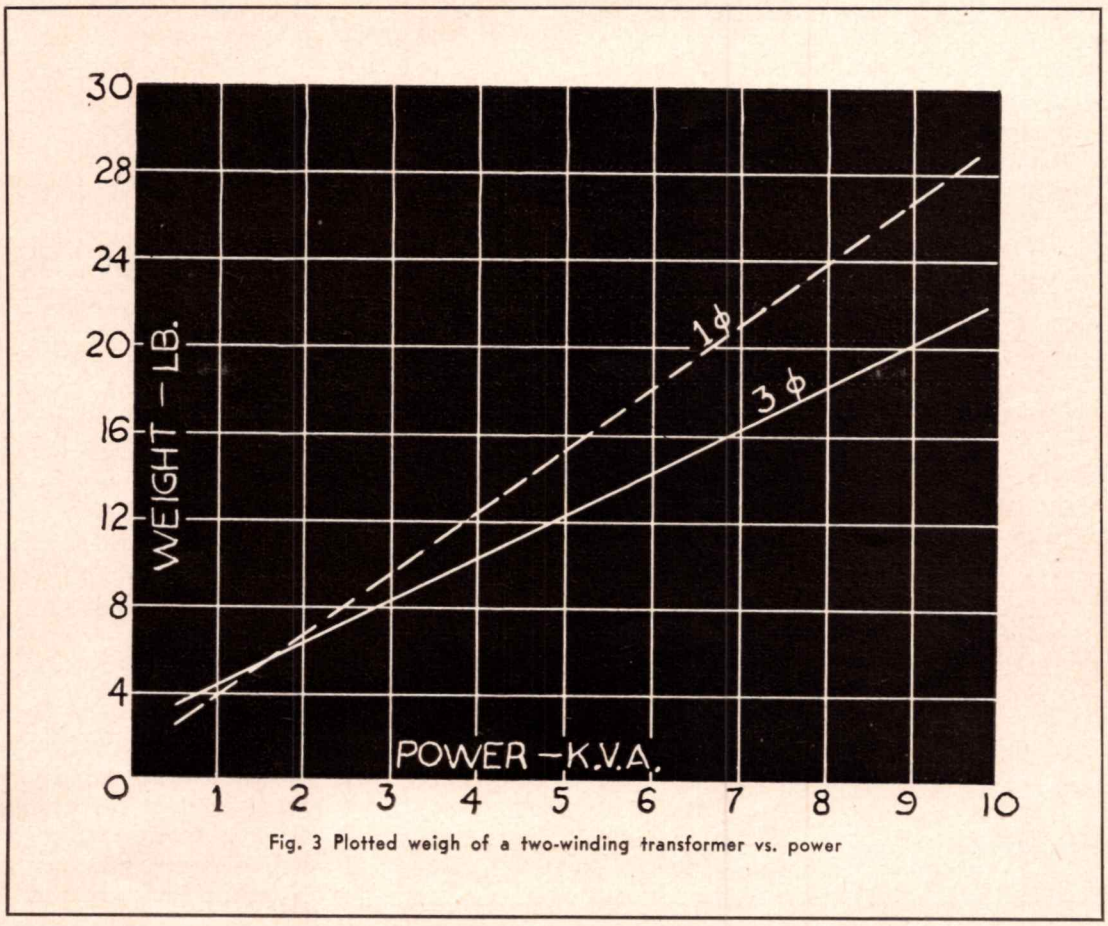


Fig. 3 Plotted weigh of a two-winding transformer vs. power

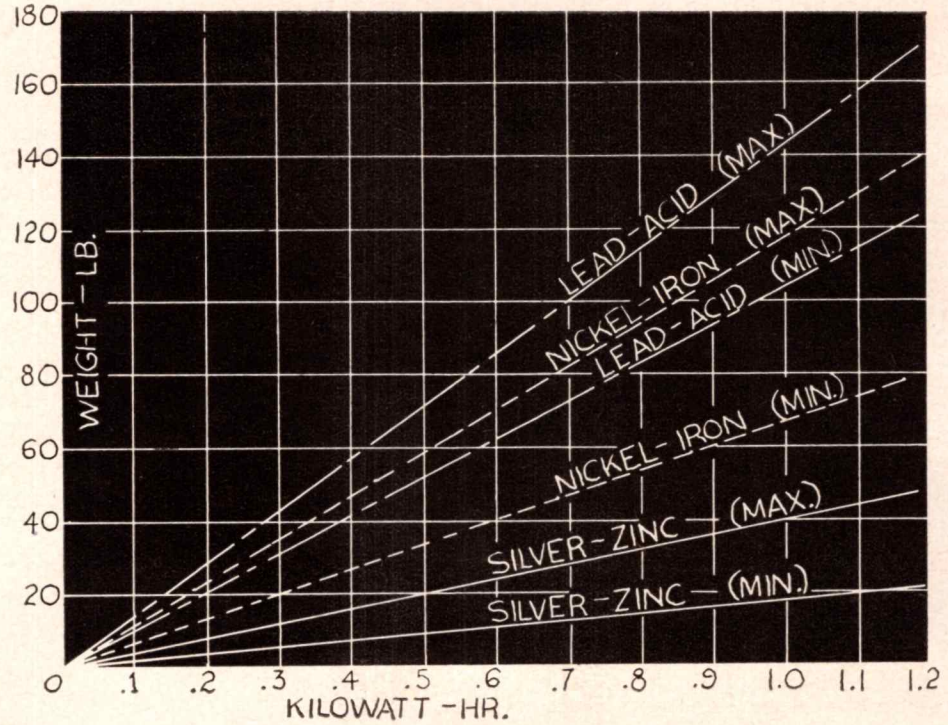


Fig. 4 Weight of electric storage battery vs wattage

Electric Power Control Equipment Weight

Unit	Weight-lb/Unit
28 V.D.C. Generator	30.
28 V.D.C. Battery	3.
120 V.D.C. Generator	60.
115 V.A.C. 1 Alternator	40.
120/208 V.A.C. 3 Alternator	40.
Inverter	10.

Circuit	Flight Phase →	Take Off	Cruise	Landing
	Duration-Min →	0.5	166	0.5
(1)		200	200	200
(2)		350	350	350
(3)		1400	—	—
(4)		—	500	500
(5)		150	150	150
	Total V.A.	2100	1200	1200

rpm, and a = An emperical constant.

For a 28 vdc generator this equation becomes

$$W = 31.0 \left(\frac{Wo}{n_1} \right)^{0.61}$$

For a 120 vdc generator the equation becomes

$$W = 33.4 \left(\frac{Wo}{n_1} \right)^{0.61}$$

For a 115 vac alternator

$$W = 26.5 \left(\frac{Wo}{n_1} \right)^{0.61}$$

The plots of these power generating units are shown in Fig. 2 for various values of Wo/n_1.

Power Conversion

INVERTER: The inverter consists basically of a dc motor, ac alternator and control box combination. The basic relationship of power per rpm to weight of rotary equipment was found to apply to the inverter as well as the power

generation units. The equation of the inverter was found to be

$$W = 97.1 \left(\frac{Wo}{n_1} \right)^{0.5}$$

The curve of the inverter weight is shown in Fig. 2.

TRANSFORMER: The weight of ac transformers has been found by Westinghouse engineers to be a function of load in va for a given winding. In Fig. 3 is plotted weight of a two-winding transformer vs. power. To find the equivalent two-winding power in kva the following relation must be used.

Equivalent two-winding kva =

$$\frac{E_1 - E_2}{E_1} \times \text{kva}$$

where: E_1 = High voltage line voltage, and E_2 = Low voltage line voltage.

Power Control

The electrical power control equipment is a relative constant weight for a given voltage. The table shows the weight of control equipment for various power and conversion units.

Battery

The electric storage battery weight has been found a function of watt-hour requirement of the system.

In the analysis of the electrical system it will be necessary to determine the watt-hour of each functional circuit for each flight condition. This can be shown by the table showing power in volt-amperes.

The watt-hour is then computed for each of the above flight phases by the following equation and added

$$W_1 = \frac{va}{60/T}$$

where: W_1 = Watt-hour, va = Volt-ampere, and T = Duration of operation-min.

Thus in the above example table

$$W_1 \text{ (Take-off)} = \frac{2100}{60/.5} = 70 \text{ watt-hr.}$$

$$W_1 \text{ (Cruise)} = \frac{1200}{60/166} = 3320 \text{ watt-hr.}$$

$$W_1 \text{ (Landing)} = \frac{1200}{60/.5} = 40 \text{ watt-hr.}$$

Adding,

W_1 (total) = 70 + 3320 + 40 = 3430 watt-hr.

Shown in Fig. 4 is the weight of electric storage battery vs. watt-hour for various types of batteries. If the value of total watt-hr. for a given aircraft exceeds the scale of Fig. 4 the watt-hr. can be broken up into any convenient number and the weights added. Thus for the example above of 3430 watt hr. the weight of 3,100 watt hr. plus a 430 watt hr. battery can be added.

Power Lines

The weight of electric power transmission line is a function of current in amperes. Knowing the amperage load of a circuit the weight of electrical wiring per foot can be read from Fig. 5.

Total Weight

The total weight of the electrical power system will be the summation of weights of those required components that have been discussed.

The method presented here has the advantage of being broken down into components of the system. Thus correction to system weight can be made to any portion of the system as design progresses.

The accuracy of the method is extremely great, since misleading statistical data has been kept to a minimum and the method is based for the most part on weight influencing design parameters. END

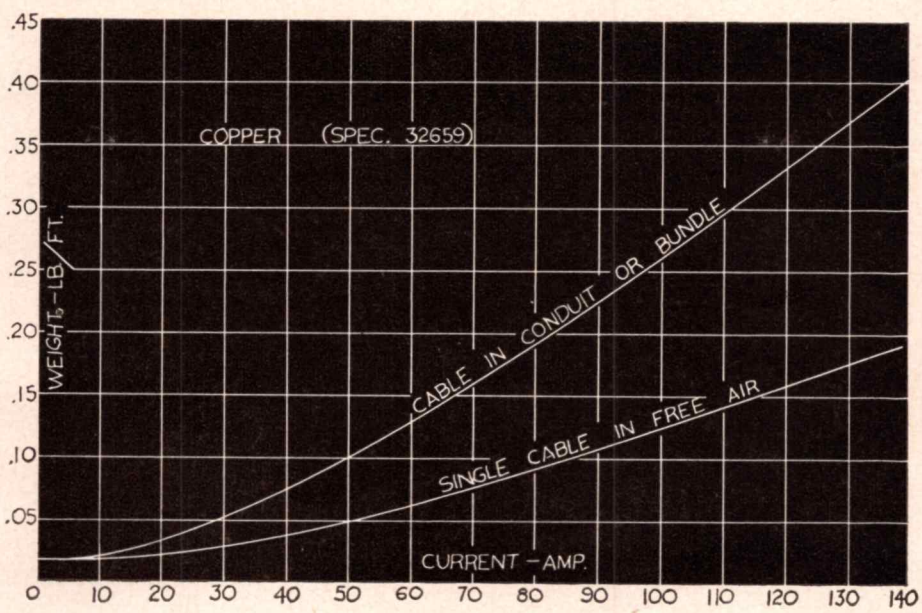


Fig. 5 Electric power transmission line weight

Progress in Hydraulic Design Engineering

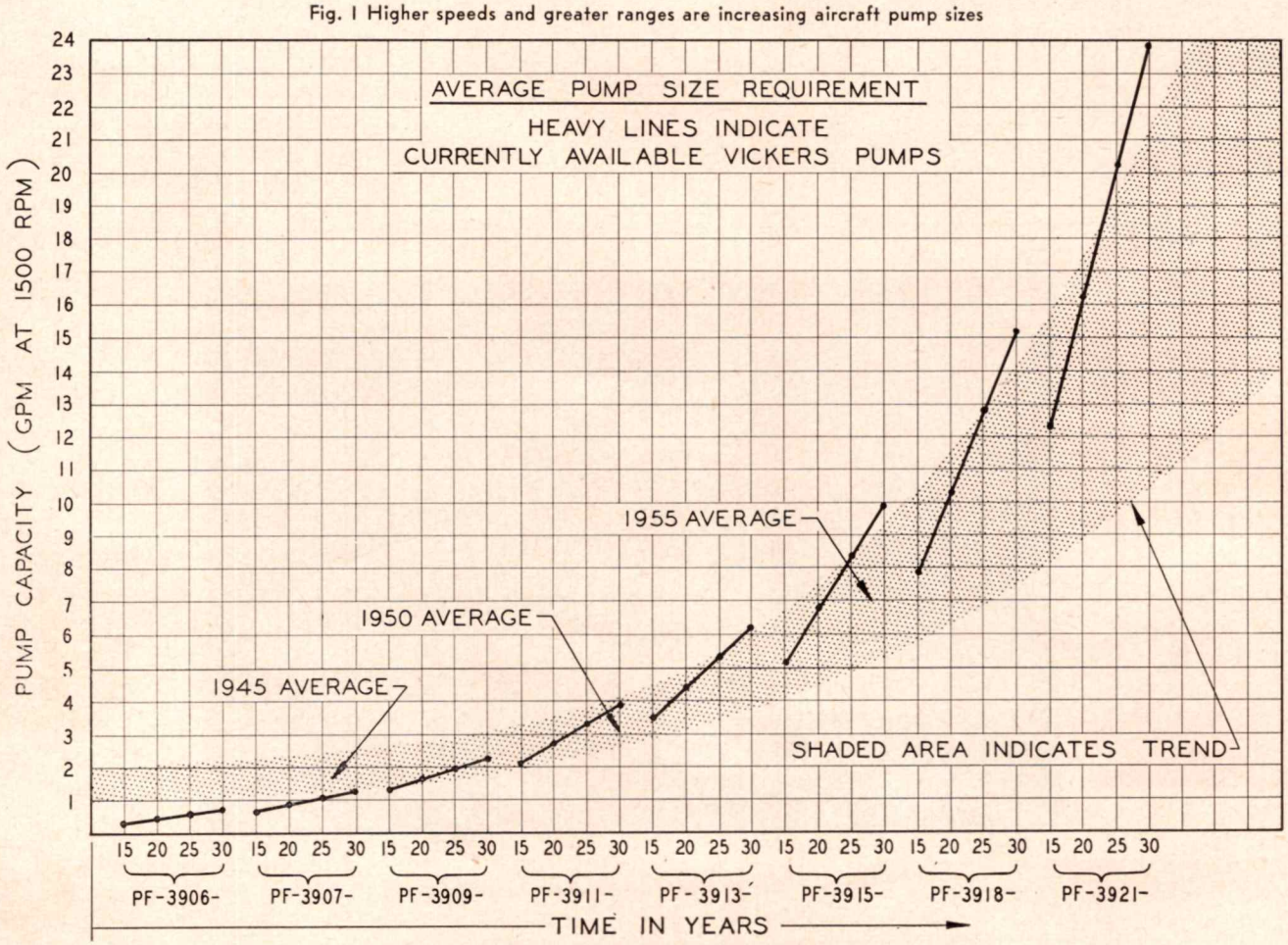
By GEORGE McLAUGHLIN

Increased power, reduced weight and improved efficiencies meeting new system demands

THE increased use of hydraulics in aircraft is reflected in many ways. Fig. 1 shows how average pump sizes required for aircraft is increasing. As shown, pump requirements have gone from an estimated two-gallon capacity (at 0150 rpm) average in 1945 to an anticipated average seven-gallon size for 1955. Some systems requiring pumps capable of delivering more than 25 gpm at 1500 rpm appear a likely possibility within the next few years. The list of services performed by hydraulics in today's aircraft, and pending release in newer aircraft, reads like an aircraft glossary.

It must be remembered that two pumps have been considered a minimum requirement for hydraulic systems for many years. Recent designs have seen this requirement increased to four, six, and even as many as 20 where special circumstances have so dictated. Several recent aircraft designs have found use for more than one hydraulic system. Each of these systems uses one or more pumps. Sys-

Fig. 1 Higher speeds and greater ranges are increasing aircraft pump sizes



tem growth may possibly have advanced along a more accelerated trend curve because of the increased number of pumps used per aircraft. The curve of pump sizes, then, is not a true measure of hydraulic system capacity growth but rather indicates growth of a single key component.

Pumps being the heart of hydraulic systems, their direction of development influences other system factors. For instance, fixed displacement pumps with accumulators and unloading valves were satisfactory in earlier days when the hydraulic system did a few intermittent jobs. These installations were inactive 90 percent of the time. Today's aircraft use automatic variable displacement pumps to provide continuous varying flows at constant pressure for numerous and continuous demand special hydraulic system functions. Servo pumps, electronically controlled pumps, and reversing flow pumps are indicative of other refinements. Numerous special service valves, actuators, and hydraulic motors also see use.

High Speed

More hydraulic system capacity means more weight of equipment. This is especially true of pumping capacity because of the operating speed limitations imposed as the pump size increases. The smaller Vickers pumps, for instance, will operate at speeds as high as 9100 rpm; larger sizes, however, are limited to speeds in the 3000 to 5000 rpm range. Jet engines, with their high shaft rpm, readily provide high speed accessory pad drives. The low speed requirements for pumps penalize a pump-engine combination, weight-wise and envelope-wise, by requiring step-down gearing. Designs that will permit higher operating speeds and consequent increased delivery without increased size are now in the development stage.

High Pressure

In recent years the increasing demands on hydraulics seemed to point to higher pressure systems. In theory, the higher operating pressures would permit smaller accessories and smaller lines. Actually, accessories presently designed

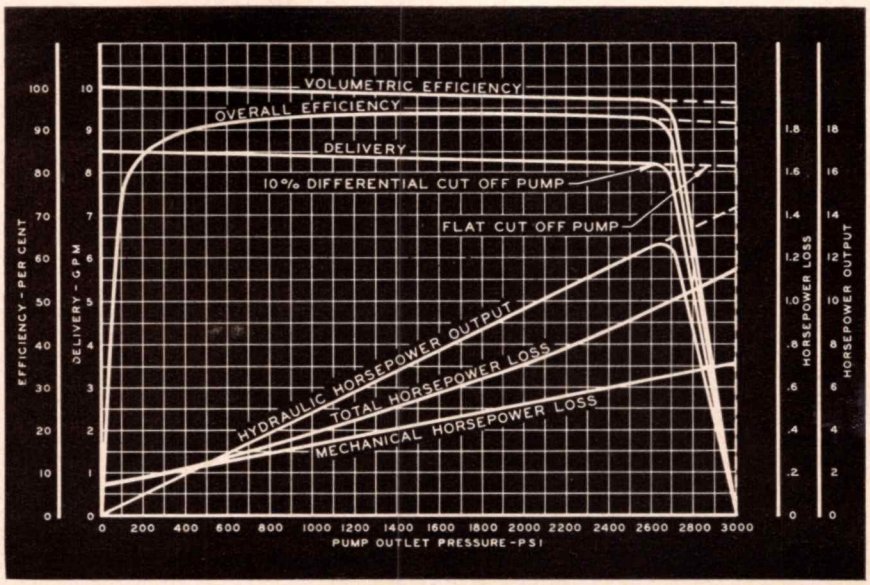


Fig. 2 Comparison of flat cut-off pump with an equivalent conventional pump

for higher pressures are sometimes larger and heavier than equivalent 3000 psi units. A conventional system converted from 3000 psi to 5000 psi operation using currently available components would, therefore, occupy less space but might be heavier. Some close coupled servo circuits, on the other hand, have realized not only space advantage but weight saving as well by operating intermittently at the higher pressures.

Several manufacturers have hydraulic pumps in which they have proved the design principles that will permit 5000 psi operation. As these principles are worked into a form suitable for aircraft use, appropriate lines, valves and actuators will evolve to produce smaller and lighter overall hydraulic systems.

Higher Temperature

Higher operating temperatures demanded of hydraulics in current aircraft complicate the problem of higher operating speeds and higher pressures. The former standard (—65 deg. F. to +160 deg. F.) is no longer applicable. Some aircraft hydraulic systems are already operating in the 250 deg. to 300 deg. range; further military requirements in excess of 550 deg. F. are anticipated. These factors require the equipment manufacturers to go back and re-engineer high pressure designs developed under the older temperature range criteria. Created is a need for fluids, seals, and metals capable of satisfactory operation at the higher temperatures. Rubber seals, for instance, give way to metallic seals, hollow stainless steel tubes in the form of conventional "O" rings, which perform the same function. The metallurgical problem for accessories involves strength-weight ratios at elevated temperatures. The use of newer metals such as magnesium-zirconium alloys or special steels for aircraft application will contribute to solutions.

Hydraulic Fluids

Increasing temperatures in hydraulic systems mean that the presently used petroleum type hydraulic fluid (MIL-0-5606) will soon be obsolete. Safety fluids (non-flammable) also rate a lesser priority in the face of the new requirements. A good, combination high temperature fluid and safety fluid would have ready acceptance, of course. Synthetic fluids must now be formulated, however, to obtain the following minimum characteristics:

1. Inherent stability at temperatures up to 500 deg. F., plus (missiles up to 700 deg. F., plus), 2. Adequate lubricity even at high operating temperatures, 3. High vapor pressure and flash point, and 4. Good Viscosity Index over the range of —65 deg. F. to +500 deg. F.

In addition, the fluid should exhibit hydrolytic stability if at all possible.

The need for such a fluid has

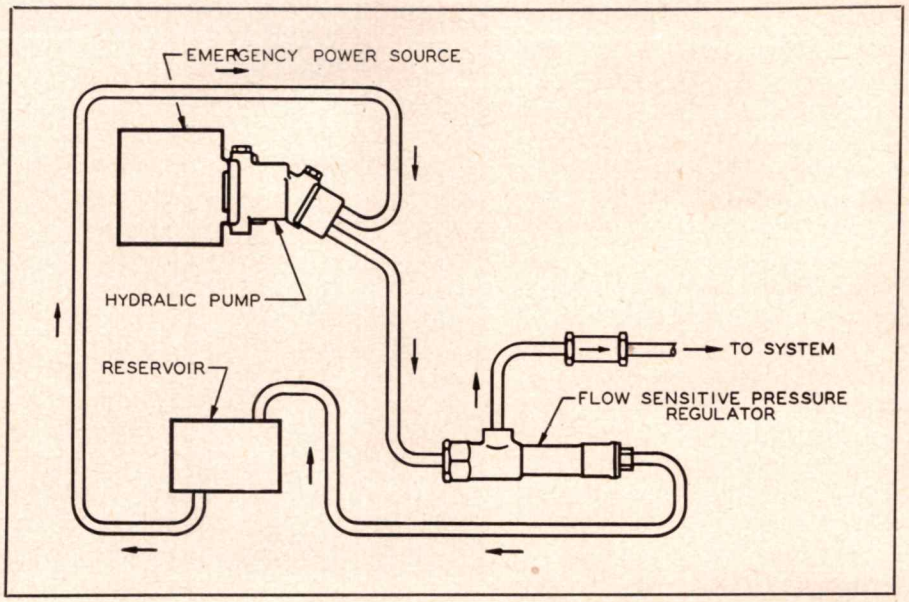
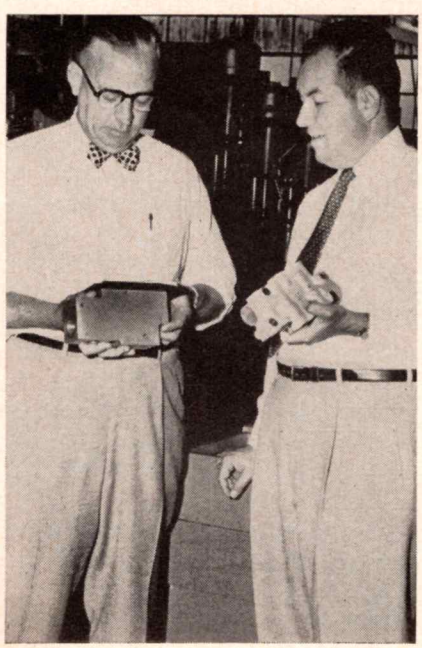


Fig. 3. Typical circuit incorporating flow sensitive pressure regulator

been emphasized by the recent preparation of a new MIL specification for high temperature aircraft hydraulic fluid. This specification is now being coordinated through the Air Force and Navy and upon its release will further spur the efforts of the manufacturers of synthetic fluids. Although there is no fluid now commercially available which will meet all of the requirements of this new specification, several companies have developed experimental formulations which show great promise, particularly R. M. Hollingshead, California Research and Monsanto.

C. Shreve, Production Manager at Vickers El Segundo Plant, shows old pump control valve design in contrast to new held (r.) by E. Brown, chief valve engineer



Servo Systems

Hydraulic servo applications are following a pattern of increasing uses. The familiar hydraulic servo system provided for World War II gun turret operation simply supplied power amplification to allow the gunner to overcome resistance to movement of his guns by the fast-moving air stream as well as the normal inertia of the turret itself, including guns, gunner, and ammunition. Growth of power control systems to make better use of aircraft armament has almost removed the human operator from the picture and resulted in fully automatic electro-hydraulic servo gun installations.

Other high power, high response needs have brought about the application of servo systems for many other aircraft requirements. Servo pumps have been supplemented by servo valves. Generally, where a single circuit serves a single function, a servo pump and an actuator are employed as the simplest possible system. Where more than one function must be served by a single power source, then several servo valve operated actuators are used in conjunction with a single automatic pressure compensated pump supply source.

In laboratory set-ups, servo valves have proved capable of full power response from electrical signal input to mechanical power output at frequencies as high as 50 cps with rated inertia loadings and up to 300 cps with lesser inertia loadings. In general, present applications in aircraft do not involve frequencies beyond about 20 cps. The purely mechanical connections in servo systems tend to be limiting. By manifolding the servo valve to a motor or linear actuator, a very rigid hydraulic connection results which helps provide excellent dynamic response. Hydraulics in combination with electronic controls generally handle varying loads better than other methods.

Missile Requirements

Work in the Government guided missile program is affording hydraulics manufacturers the experience of testing and installing for an entirely different set of requirements. Missile components must be long on reliability while life requirements are relatively short. This means that emphasis has shifted from the situation where, for example, a desirable test report might indicate that of 10 pumps tested, nine were capable of 1000 hr. or more of operation while one may have malfunctioned within the first hour. For missile application service, no malfunction can be tolerated. The entire 10 pumps must function perfectly for an hour or whatever might be the required life figure. The fact that every pump might fly to pieces upon completion of one hour and one minute of service is of little or no consequence. The mission of the missile would have been completed by that time.

Theoretically, long life serviceability for hydraulic components would be totally sacrificed in missile applications. This is not so, however, because of the unusually long testing periods which are many times required (50 to 100 hr.). The requirements for missile application are being met in either of two ways: (1) Existing hydraulic designs are overworked by operations at temperatures, speeds, and pressures above rated values, or (2) new designs or redesigns are being developed to meet the specific life, temperature, speed, and pressure characteristics for missile hydraulics. With proven specialized designs not yet available, it is necessary in most cases to overwork existing components. Fortunately, due to the limited life requirements, this can be done. Developments are in progress by most manufacturers to produce accessories capable of the desired reliable short life operation at higher temperatures, speeds, and pressures with the expected lower manufacturing costs and hoped-for corresponding reductions in weight and size.

Recent Developments

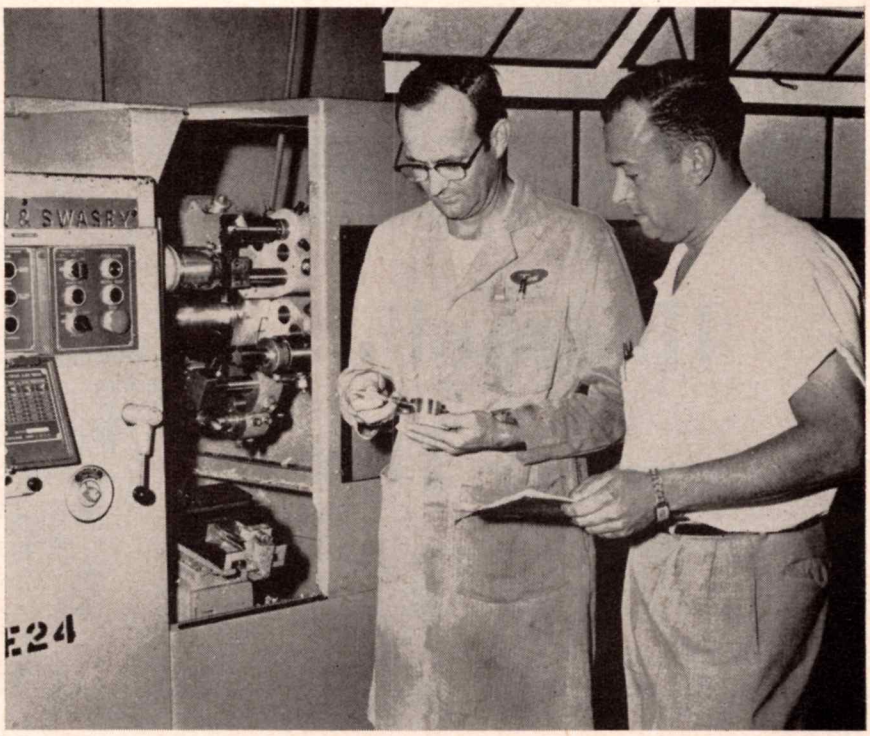
Components capable of higher pressures, higher speeds, and higher temperatures are being produced but many still have one foot in the laboratory. Significant advances have been made, however, in other areas to bring improved performance to conventional hydraulic systems. One of these is the variable displacement pressure compensated pump, having a flat cut-off automatic pressure control. The development of the flat cut-off control produces maximum displacement at full rated pressure. This provides 10 percent more power with no increases in size or weight. The performance curves in Fig. 2 compare a flat cut-off pump with an equivalent conventional (10 percent pressure drop) pump.

While variable displacement pumps take over as prime hydraulic power sources, small fixed displacement pumps continue to provide emergency stand-by safety. Instead of being electric motor-driven with the resultant dependency on a battery charge, the auxiliary hydraulic pumps are now frequently driven by ram air turbines. The pumps selected for application must have the highest possible overall efficiency in order to minimize the size and weight of the turbine. This has favored use of the piston pump type of design. Similarly when the pump is electrically driven, very high overall efficiency means longer use from a given battery charge or a smaller electric motor.

In order to get the most out of a given size ram air turbine emergency power source, a special flow sensitive pressure regulator has been introduced into emergency circuits. This new valve automatically senses reduction in turbine torque at low airspeed which would permit the pump to stall the turbine and reduce pressure setting so that a stall-out does not occur. This means that a 3000 psi emergency circuit may deteriorate to 1000 psi or less, but the residual turbine torque remaining at low speed will continue to produce hydraulic flow for use by the hydraulic system.

Progress in many cases has been evidenced by the design of multi-purpose control valves. These combine a variety of functions in a single housing as opposed to the use of a variety of separate valves connected by pipes or hoses. For example, the flow sensitive pressure regulator just mentioned sometimes includes the main system relief valve as an integral part of the unit.

A recently developed pump control block incorporates in a single housing the functions of system relief valve, manual firewall shut-off valve, thermal vent valve, pump isolation valve, and pressure warning switch. Another typical example is a new double-acting relief valve which, when inserted across the two lines to a reversing motor, provides relief for whichever happens to be the high pressure line. This unit requires 85 percent fewer pressure connections than a comparable conventional installation, thereby substantially reducing the number of potential leak spots, the complexity of installation, space required, maintenance costs, and installation weight. Although of advantage in the design of a specific airplane, the manifolding of several valves into a multi-purpose control block results in a non-standard accessory. Adversely effected is the long-time concept of standard interchangeable accessories which can be readily used on any of a number of aircraft types. END



Workmen at multi-head machine for high volume aircraft accessory production

ACCESSORY power requirements in aircraft have been steadily increasing since the early days of powered flight. These expanding power requirements in recent years have been attributed to the increasing number and size of electrical devices to be powered from the airplane electrical generating system. Coupled with this demand for more electrical power has been a requirement of the electrical industry for constant speed operation of the generating equipment. The problem then becomes one of not only efficiently extracting power from the engine to drive the accessory but also delivering that power at constant speed under the widely varying and unrelated speed and power conditions of the main aircraft engine.

It may be of interest to review the characteristics of the hydraulic transmission and the merits and problem areas which may exist in their application. For a hydraulic transmission, the three most important requirements are the ability of the unit to transmit the power required for the driven accessory, to do so over the operating speed range of the prime mover, and to fit within the severe space limitations of the typical aircraft installation. In addition to these fundamental requirements, the efficiency of transmission, ability to maintain close control of output speed and general durability under the exacting environmental conditions of modern aircraft, are items of real interest to the potential user.

In the matter of power requirements, designers of electrical generators have for many years arranged their equipment such that the machine can deliver, for duration, power appreciably in excess of the normal rating of the unit. Generators are, in fact, rated for continuous output, usually limited by thermal considerations, and for overloads of 150 percent of normal rating for 5 minutes and 200 percent for 5 seconds. Loads in excess of 200 percent are not usually recognized, but they can occur and we have observed in the field 300 and 400 percent loads existing for short periods during random paralleling or similar unanticipated conditions. Since the generating equipment can, without deleterious effect upon itself, produce these overloads and electrical system functioning requires fault clearing capacity of these magnitudes, we have come to the reluctant but necessary conclusion that these five minute and five second ratings must be sustained by the transmission and the unit must not be damaged by very short duration loads of 300 to 400 percent of normal rated.

From the standpoint of operating speed range, there are conditions extending from idle to maximum engine speed under which the electrical system can impose both normal and overload power upon the generator and consequently the transmission. This gives a load-speed schedule for the transmission.

In some instances, a desire has been expressed for part load capacity at engine speeds below idle, in order to obtain constant frequency alternating current power with the engine windmilling. This would be the sloping line to the left of the idle point on the normal rated power curve.

In terms of actual input speed to the transmission, as might be expected, the various engines have had an appreciable divergence in both speed ranges and ratios of maximum to minimum rpm at the power take off pad for the transmission input. The size of a hydraulic transmission can relate very directly to the operating speed range or ratio so this, with load, becomes a significant design criteria. The widest speed ratios we have encountered have been on reciprocating engines at 3:5:1 and the narrowest on certain turboprop engines that almost, but not quite, run at constant speed.

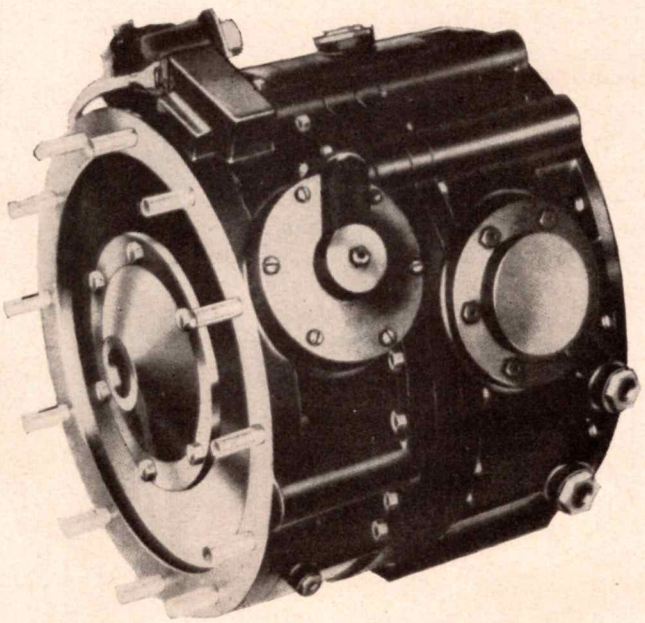
Naturally turbojet engines have presented the bulk of new requirements because of their widespread

AIRCRAFT HYDRAULIC SYSTEMS

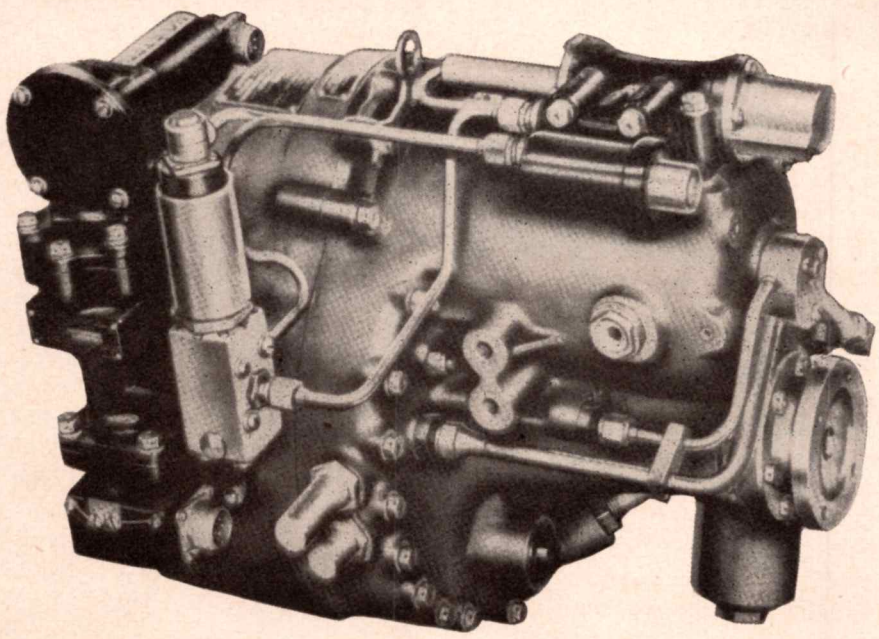
Hydraulic Accessory Drives

By CARL L. SADLER
Manager, Aviation Division,
Sundstrand Machine Tool Co.

Constant speed power source for generating equipment is becoming an increasing demand



use in new military aircraft. Speed ratios of 2:1 ranging up to a maximum of 3:1 are common on this type of power plant. The absolute speeds at present extend from 2000 rpm at idle on one or more engines to maximum speeds as high as 10,000 rpm on others. In those cases where a standard AND pad is used to drive the transmission, the maximum speed will usually not exceed 7,000 rpm, but an appreciable weight saving can often be realized by eliminating any gearing and driving the unit directly at engine rotor speed. The main conclusion which we have so far been able to draw on the matter of designing transmissions for the pattern of engine requirements is that standardization of types for cross utilization on various engines might be a good idea but we don't know how to go about it very well without getting into more weight, bulk or inefficiency than anyone would care to accept. In other words, specially tailored transmissions for specific applications will, for sometime, be the rule rather than the exception.

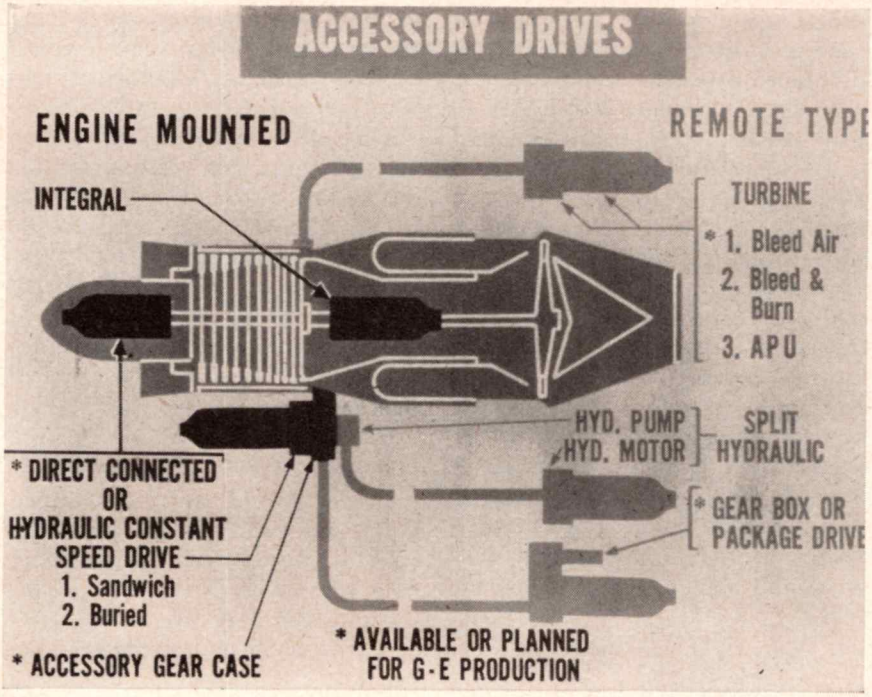


The operating efficiency of a hydraulic transmission is an important consideration in its evaluation. Generally speaking, minor differences in shaft horsepower extracted from the engine would be inconsequential, in terms of engine operation or efficiency, but these differences translated into heat in the transmission fluid can mean the difference between a comparatively minor and a major cooling problem. Achieving high transmission efficiency is not difficult if the user is willing to accept the relatively large size and weight of a unit designed for low operating speeds. Obviously, this is not in keeping with the requirements of high performance aircraft and it is necessary to employ both high speeds and highly stressed parts to provide an acceptable small unit. It has been our experience that churning losses of fluid in contact with parts rotating at high speeds can become very appreciable, and a great deal of serious attention must be paid to lubricating passages and adequate scavenging of the transmission.

Many of the fixed losses in a transmission remain constant irrespective of size of unit, so higher horsepower transmissions may be expected to be more efficient than their smaller counterpart. So many factors enter into a determination of the efficiency of a unit in a particular application that it is difficult to discuss specific values of efficiency without introducing appropriate qualifications on these factors. A typical efficiency curve for a split system type transmission has been graphed. It was noted that the efficiency remained quite constant over the speed range other than the small drop that occurred at high speeds due to churning and windage losses in rotating parts. No absolute ordinates are shown on the figure for reasons already given, but as a general statement we usually think in terms of 80 percent average efficiency for this type of system with transmitted powers of 50 hp or more. Long or restricted connecting lines resulting from a too distant location of the motor unit can result in adverse pressure drops and a consequential reduction in efficiency.

In the case of the close coupled units, not only are the losses attendant to connecting lines eliminated, but it is also feasible to use the differential transmission principle, in which a large portion of the power is transmitted mechanically. The result is a unit of fundamentally higher efficiency than the split system type. The theoretical efficiency curve for this type of mechanism is shown as Curve A on page 49. The peak efficiency is reached at the time when there is no transfer of hydraulic energy. At this time, all of the output power occurs through mechanical gearing with the hydraulic elements providing reaction torque only. As the relative proportion of hydraulic power transfer increases, the overall efficiency declines as shown on Curve A. The actual efficiency curve for such a unit is more likely to appear as shown by Curve B on page 49. This curve takes into account the quite major factor of torque losses in the system due to churning and similar causes. By appropriate design of the transmission, it is, to a certain extent, feasible to adjust the peak efficiency point to suit the airplane-engine requirements. For example, it may be desired to have peak efficiency and consequently minimum heat rejection at altitude idle or descent rpm of the engine, which might be as shown on Curve B. On the other hand, either ground idle or maximum speed can be critical and can be favored by an appropriate shift either downward or upward in the speed at which peak efficiency is attained.

As in the case of split system units, we hesitate to assign absolute values of efficiency for close

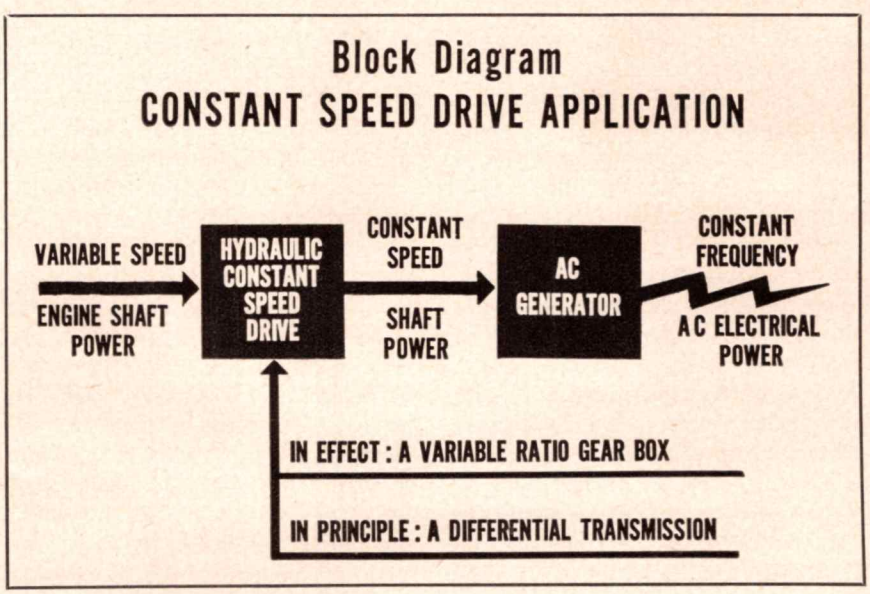


coupled, differential transmissions because of the variables of each application, but peak efficiencies in excess of 85 percent are quite readily achieved, with minimum efficiencies at the extreme speed ratio points on the order of 80 percent, or slightly less for extreme wide range applications.

The question of dissipation of heat produced in a transmission is an interesting one. The most obvious system is to provide a separate reservoir for the transmission fluid, an air to oil cooler and connecting piping. This system, while quite feasible, has the undesirable aspects of extra drag and the weight of the cooler, reservoir and piping. A solution much more attractive to the airplane designer is to simply tap into the engine oil system, thereby making use of the already available storage and oil cooling capacity of the engine lube circuit. With oil porting through the transmission flange or the unit built into the gearbox, even the external oil piping is eliminated. Naturally there is some reluctance on the part of engine manufacturers to approve the use of their engine oil supply for an accessory. The advantages of this type of installation are sufficiently large, however, that all of the major engine manufacturers have either approved or are seriously considering this type of configuration on their new engines.

The use of engine fuel as a sink for transmission heat rejection, inherently obtained with the integrated engine oil system, has the immediately apparent advantage of eliminating drag associated with air-oil cooling. On some engines, the combined engine and transmission heat rejection can exceed the cooling capacity of the engine fuel supply under certain low fuel flow conditions, such as altitude idle or airplane descent. In these instances a supplementary air to oil cooler can be provided to remove the surplus heat. Since the auxiliary cooler is in use only during short duration flight conditions, the bulk of the mission can be accomplished without cooling drag loss. It is also interesting to note that absorption of transmission heat by the fuel represents useful work in the thermal cycle of the engine. This, coupled with the basic high thermal efficiency of extracting engine power as shaft horsepower, makes this system one with singularly high overall efficiency, an efficiency not attainable, to the best of our knowledge, by any other method of extracting and transforming engine power into useful accessory work.

Turning now to the matter of accuracy of output speed control, it is apparent that the requirements will vary greatly with the type of driven accessory. A dc generator, hydraulic pump or similar unit, the operation of which is relatively unaffected by minor changes in speed, requires only that the speed remains within broad limits defined by critical underspeed or overspeeding. Constant frequency ac generators, on the other hand, require precise control of speed, not because of any inherent characteristic of the machine itself but because of the requirements for precise frequency supply to the electrical and electronic components of the airplane. These allowable limits have been progressively narrowing and today 0.25 percent



maximum variation in steady-state output speed is specified in many applications, to be maintained over the complete range of input speeds, loads and environmental conditions. Similarly, transient deviations in output speed, under rapid engine speed or power changes or with sudden electrical load applications or removal, must be controlled to relatively narrow limits, and the recovery to steady-state limits must occur within a period of 0.5 to 1 sec. or less.

Of the items which could be troublesome, ambient and fluid temperatures are perhaps most significant. Realizing the wide range of temperatures through which the mechanism must be operated, it is no great problem to design hydraulic transmissions in which running fits and clearances can remain adequately constant over the prescribed range. The problem relates almost entirely to the fluid used and the resilient packings employed for sealing purposes. At the accepted lower temperature limit of —65°F, the fluid must still have a low enough viscosity to be pumpable from the reservoir to the unit and to permit the transmission govering system to function within limits. In our opinion, this places an upper limit on fluid viscosity of approximately 15,000 centistokes. Since it is obviously desirable to have as viscous a fluid as possible at high temperatures, the available selection narrows rapidly.

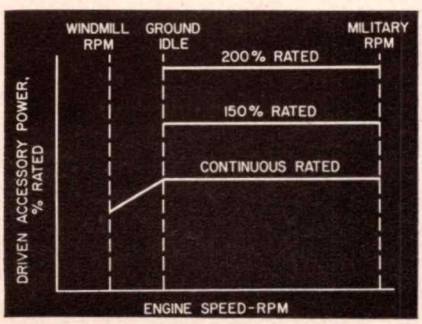
It was quite natural that the first fluid employed for transmission use would be MIL-L-5606, the general purpose airplane hydraulic fluid. It was our experience, however, that this fluid did not have either the shear stability or anti-foam qualities necessary for a scavenged case, heavy duty transmission. As a result, MIL-L-6387, a di-ester base synthetic fluid, was developed by Pennsylvania State under Air Force sponsorship and is being used with good success in all B-36 aircraft. The engine people, faced with much the same problem, brought into use MIL-L-7808, a di-ester fluid quite similar in characteristics to MIL-L-6387. Our experience with MIL-L-7808 has been very good and we expect to use it on all new installations. Starting and operation at —65°F can be readily accomplished with it or either of the other fluids.

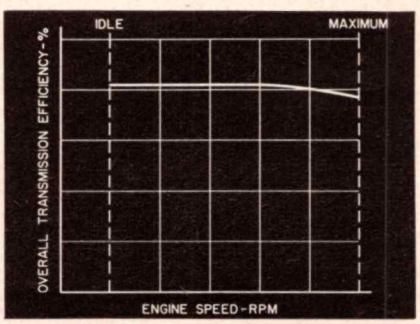
The di-esters are also reasonably good fluids at elevated oil temperatures. On several engines we have been asked to operate continuously at 270 deg. F oil inlet temperature with intermittent higher temperatures. Through tests, this has been shown to be feasible, and in fact, on one engine a portion of the engine model test was run at 325 deg. F with our drive installed and operating. It is quite apparent that continuous running with oil temperatures of 350 deg. F or higher will become a requirement in the near future. We face this prospect with no particular apprehension, since the engine man, who will prescribe limiting system temperatures, must also have at his disposal the same improved materials, particularly packings, which we will need.

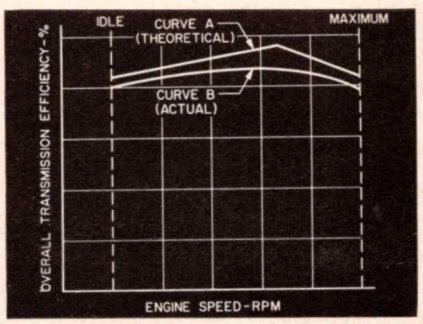
Altitude operation presents no problem to a hydraulic transmission, since the working circuit is completely independent of ambient pressures. This means that as much power can be delivered by the hydraulic transmission at extreme altitudes as on the ground, a feature which is not readily attainable by most other types of transmissions.

Similarly hydraulic units, because they are enclosed from the elements, are not affected by humidity, sand and dust, salt spray, fungus and kindred adverse atmospheric phenomena.

A question is often asked as to the desirability of hydraulic transmissions. In keeping with accepted practice for military application, we have designed all units for 500 hr. overhaul life. On the B-36 units, however, the established removal time is now up to 800 hr. and we see no fundamental reasons why 1000 hr. or more between overhauls cannot be achieved with appropriate design for the longer life and assuming at least average maintenance in the field. Complete overhaul of B-36 units is and for several years has been, entirely handled at the Air Force depot without appreciable assistance from company personnel. The Navy is now in the process of setting up similar overhaul procedures on units being delivered to them. We have felt that one of the fundamental requirements in the design of this type of mechanism should be a freedom from any specialized machining or assembly problems which would adversely affect life or preclude expeditious overhaul of the units at an established military or commercial overhaul facility. This has been accomplished, and when considered in conjunction with the high performance characteristics obtainable in a hydraulic transmission, we hope will result in others sharing our own convictions that such units have a useful and expanding place in military and civilian aircraft of the future. END







Higher Altitudes Bring New Demands

By WALTER C. SHAW
Project Engineer—Development, Hamilton Standard Division, United Aircraft Corp.

Increasing performance of turbine aircraft requires new capacities and air-conditioning systems

THE major effort in the engineering of aircraft air conditioning accessory equipment today is along the line of integration of equipment to form a system, in which each piece of equipment is linked to as many jobs as possible.

The result is a closely knit system which serves several of the needs of the airplane with less weight, cost, and performance penalties than would result from using separate specialized equipment to do these jobs. The tremendous amount of air gulped by the compressor of a turbine engine and raised to a high pressure level and temperature is the basic source of power for these jobs; function of the equipment is to translate the power into useful work. This trend has been forced by the tendency for higher speed in combat aircraft which brings with it the need for cooling much more airplane equipment.

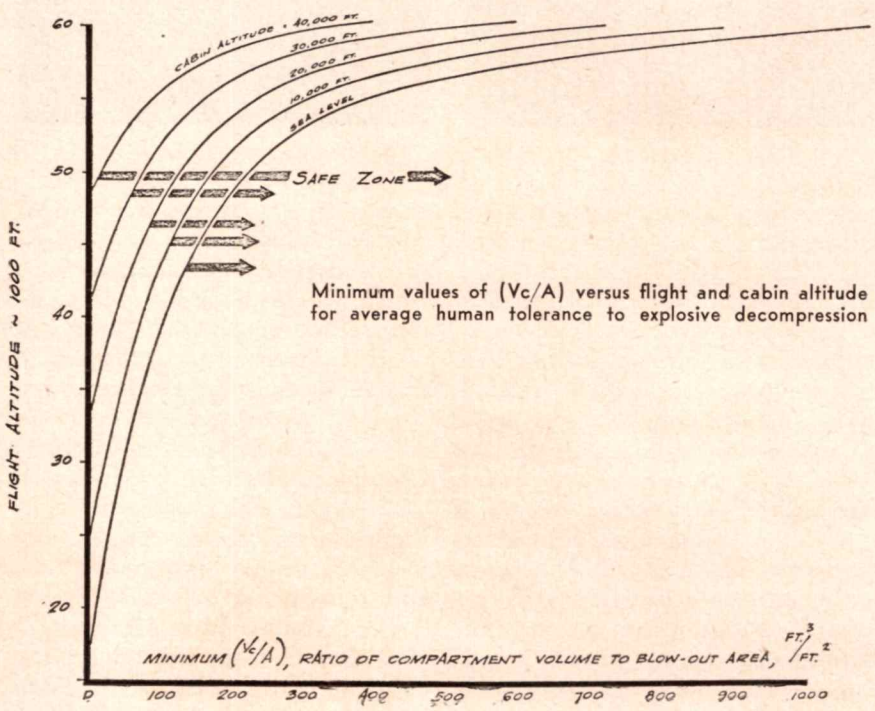
Air-conditioning systems are bigger and assuming a larger percent of the total weight of the aircraft. At the same time their importance in the final determination of the value of the airplane as a fighting weapon is considerably increased.

The modern aircraft air-conditioning system is required to do six to eight jobs simultaneously. These include cooling many critical items of equipment, pressurizing the cockpit, heating areas that must be kept above specified minimum temperatures, and ventilating the pressurized suit which the pilot wears to protect himself in the event of loss of air pressure or bail-out at high altitude.

The system which copes with all of these problems is based upon a small high speed turbine which, in combination with a heat exchanger, (basically similar to an automobile radiator in appearance and function), will reduce the high temperature air available from the engine's compressors (at up to 850 deg. F) to temperatures as low as 80 deg. F below zero for use in the various cooling jobs. Air bled from the compressor first passes thru the heat exchanger where it is cooled several hundred degrees by air drawn into the exchanger from outside the airplane. It is then funneled into the turbine, which completes the basic cooling job. Combined with this "cooling package" and carefully integrated to provide an efficient operating system are a number of other items including:

(a) Valves that automatically set themselves to maintain an element of operation such as a constant temperature, a constant pressure, or a constant weight flow of air; (b) Specially designed openings which act to check the flow of air in the ducts and prevent it from exceeding the speed of sound; and (c) Complex control systems which measure the demands of various components of the airplane for heating and cooling, calculate the amount of air required to do the job properly, and send the proper signals to the controlling valve to direct the air at the needed temperature and pressure to each of the areas being served.

In the system being designed for tomorrow's turbine-powered aircraft, air from the compressor is passed through the heat exchanger as many as three times. After one processing or "pass," some of the hot air is diverted to defog the windshield and to provide cabin heat. After two more passes, the



Minimum values of (Vc/A) versus flight and cabin altitude for average human tolerance to explosive decompression

air, now considerably cooler, is diverted for pressurizing the wing fuel tanks. This new requirement is established by the fact that pressure in the gas vapor above the fuel drops during a high speed dive and some means of retaining pressure must be used if fuel is to continue flowing to the engine.

Air also is diverted through a pressure regulating valve to the pilot's G-suit to protect him during highspeed maneuvers and also to the turn and bank gyro. The latter use of pneumatic pressure emphasizes the growing use of pneumatics in airplane systems, giving as it does higher speed, friction-free operation while eliminating the need for electrical power.

Still another replacement of electrical or hydraulic power is that covering the function of rain removal. Some of the high pressure hot air is blasted across the outside of the windshield to kep it free of rain. This new development eliminates the traditional windshield-wiper, and is manually controlled through a pneumatic switch specially developed by Hamilton Standard. The system is lighter than a corresponding electrical or hydraulic system.

One of the unusual phenomena associated with the frequently sonic speeds of the air stream passing through such systems is that of the constant "sonic boom" which occurs when the air hits a temperature control valve toward the end of the system. This annoyance now has been eliminated by a special mixing chamber which breaks up the stream of air while mixing hot and cold air to the pilot's cockpit requirements.

Still another valve, of the pressure regulation type, is used to bleed off conditioned air to the pilot's space suit, which also is equipped with its own pressure regulator. The pilot, therefore, will remain pressurized even if the cabin pressure drops.

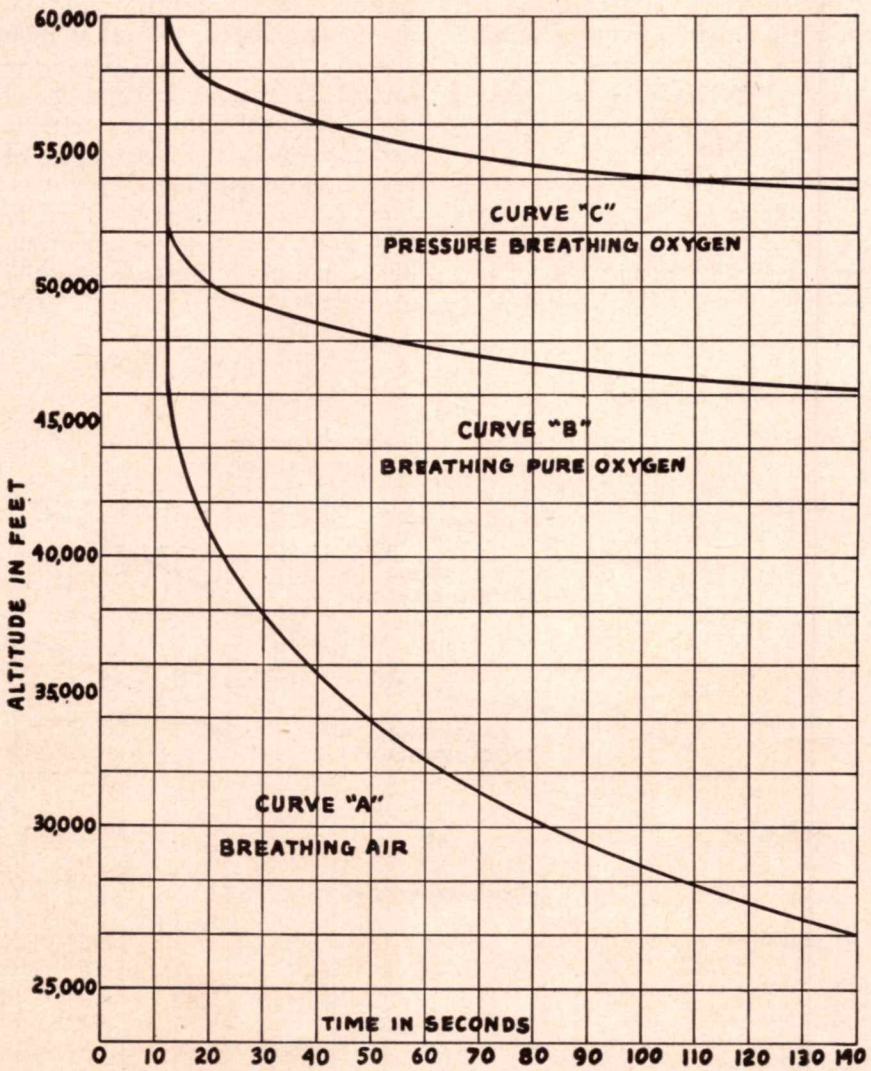
Another interesting function of the systems is that of keeping the airplane's complex electronic equipment pressurized and cooled. Electrical and electronic units crowded into small spaces in aircraft tend to short circuit at high altitude because of the decreased pressure and the resulting decrease in resistance of the air to electrical impulses.

Complicating the whole picture is the fact that the lowest temperature of cooling air drawn into the system from outside the airplane at high speeds will approximate 200 degrees F. Compression of the air at high speed will increase its temperature to that point, regardless of the actual temperature of the air in the aircraft's vicinity.

Air supply to the cabin will normally have low humidity because of the low ambient temperatures encountered at altitude. This tends to increase the rate of vaporization of moisture on the surface of the body and from the lungs at room temperature, which results in greater cooling of the body.

It is possible to increase the cabin humidity by either adding water to the incoming air or recirculating air to minimize the amount of dry ambient air introduced into the cabin. However, the humidity of the cabin air should not be allowed to rise to such a level that the dew point temperature will be higher than the temperature of exposed surfaces of cabin lining, soundproofing, insulation, or essential flight equipment or structure which will be adversely affected by moisture accumulations.

The thermal isolation from the airplane's skin of essential flight equipment may prevent a loss of heat to such a degree as to materially raise the surface temperature of those components and permit the use of higher humidities. Cabin



Comparison of Curves A, B, and C indicate that at altitude hypoxia effects begin approximately the same time whether breathing air or oxygen

lining, soundproofing, and insulating materials may either be made non-hydroscopic and non-wicking or may be protected from contact with cabin air by moisture impervious materials. Protection must also be provided against absorption of moisture from condensation on the skin of the plane which may drip onto the lining, soundproofing or insulation. Cabin air may be prevented from contacting the skin or other structure in contact with the skin by the use of water impervious insulating materials. Provisions should be made for draining and disposing of any moisture that is collected.

The basic requirements for ventilation are not significantly changed at cabin altitudes involved in normal pressurized flight. However, variation in volume of flow with altitude and various conditions of operation of the aircraft will often influence the other problems of air-conditioning since the velocity of air movement over the body affects the desired temperature and humidity level for maximum comfort.

The operation of refrigeration equipment at high altitude may be expected to be necessary due to:

A rapid rise of altitude before the cabin is cooled. (This, of course, would be alleviated by precooling the aircraft prior to takeoff), the decreased effectiveness of intercooling exchangers due to low density cooling air at altitudes and the high temperature of the supply air brought about by compression to the level required for cabin pressurization.

Because of the vital role that oxygen equipment would play in the event of depressurization at high altitudes, it is recommended that consideration be given to the following precautions:

1. Provide oxygen and oxygen equipment readily available to each occupant of the airplane and give passengers instructions in the use of the equipment prior to any flight at altitudes above 25,000 feet.

2. Provide crew members with efficient oxygen equipment providing 100 percent oxygen and designed for continuous use.

3. Require that the pilot in control of the airplane and one other flight crew member wear and use their oxygen masks at all times during flight at altitudes above 25,000 feet. This equipment should provide for readily available 100 percent oxygen breathing if the flight is to be conducted at altitudes above 35,000 feet.

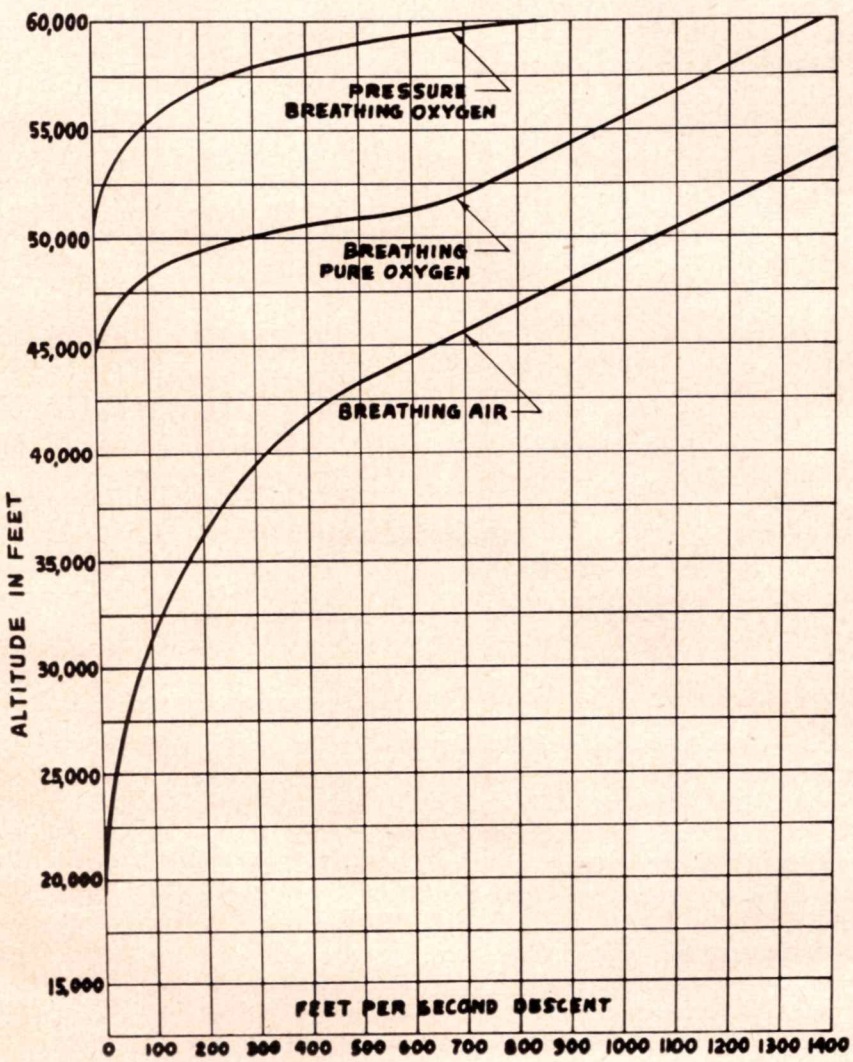
4. The minimum emergency supply of oxygen for decompression protection should be adequate to supply 100 percent oxygen to all occupants of the aircraft for a period of not less than 5 minutes. In addition to this, the requirements of the Civil Air Regulations must be met for oxygen supply at the altitude at which the flight is to be continued after a decompression.

5. The cabin attendants should be provided with portable oxygen equipment for their personal protection to enable them to take care of passengers as soon as possible after decompression.

6. Provide for all crew members to be able to use radios and intercommunication systems with oxygen equipment in use and provide for easy use of the cabin address system by the cabin attendant or crew members in the event of an emergency resulting from decompression.

In summary, it would appear that the demands for air-conditioning in aircraft to operate at high altitudes are such as to require careful study and integration of the equipment into the airframe structure from the very onset of design. A dependable pressurization system is essential to safety and a high level of air-conditioning system performance is essential to comfort. END

Rate of descent necessary to maintain consciousness following decompression



Trends in Aircraft Test Equipment

By JULIUS KENDALL

Vice-President, Greer Hydraulics, Inc.

Equipment capacities mean more space with mounting aircraft demands

AIRCRAFT test equipment has, almost of necessity, kept pace with the growing complexity and power of aircraft engine design. The pattern of interdependence of engine, accessory and test equipment has been established over the years. The future will, with equal certainty, continue to reflect parallel development.

Essential requirements in aviation and accessory testing continues to be reliability, correlation and repeatability. The problem of the future might be stated simply as that of achieving these basic test requirements in the face of continuing aviation development.

Part of the problem directly concerns the airlines and overhaul facilities. They must be equipped to cope with problems arising out of the transition of engines from reciprocating to turboprop and turbojet. Space limitations, shop layout, electrical power, air and water supply have come to assume a new and crucial importance. For instance, the power requirements of any piece of equipment needed to service reciprocating engines has rarely exceeded 50 hp. This meant that utilities and space requirements were nominal and did not require extensive additions to existing buildings to accommodate the operation of the DC-7, DC-6B and other transports. With transports operating with gas turbine engines, on the other hand, the accessories themselves frequently require prime movers up to 150 hp. and, in several instances, equipment has been designed requiring prime movers of 500 hp. These developments necessitate a completely new look at testing techniques for gas turbine engines.

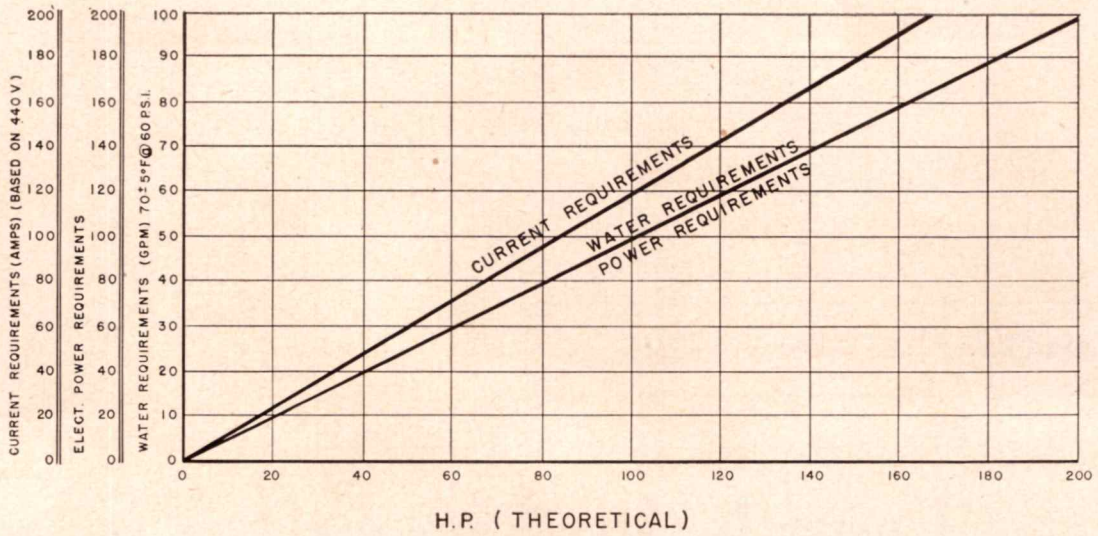


Fig. 1

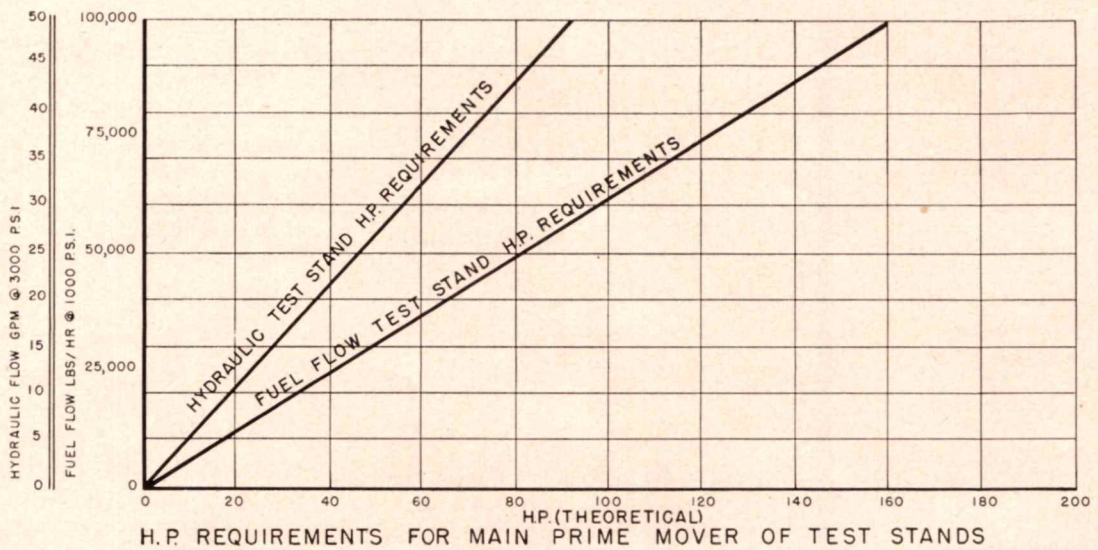

HYDRAULIC FLOW GPM @ 3000 P.S.I.
FUEL FLOW LBS/HR @ 1000 P.S.I.
HYDRAULIC TEST STAND H.P. REQUIREMENTS
FUEL FLOW TEST STAND H.P. REQUIREMENTS
H.P.(THEORETICAL)
H.P. REQUIREMENTS FOR MAIN PRIME MOVER OF TEST STANDS

Fig. 2

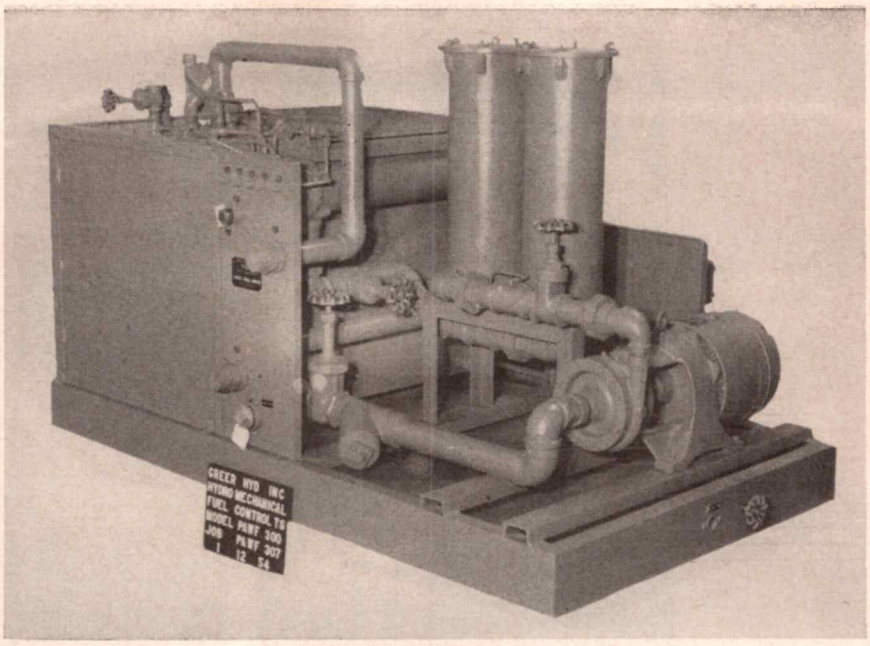
First, the testing time of these accessories may run upwards to 20 hr. as against test time average for reciprocating engine accessories of approximately two hr. The size of the equipment is two to three times larger and heavier than comparable reciprocating engine test equipment. This means that the accessory shops and buildings to accommodate this equipment must be larger.

Electrical power requirements, as shown in Figs. 1 and 2, are rapidly moving in the direction of 2300 primary voltage. Precision regulation becomes necessary in order to insure that electric drives will be capable of holding speed control specifications of one-quarter to one percent. Electronic speed controls must be engineered into this equipment. These packaged control systems are based on the Ward Leonard variable voltage principle that the speed of a dc motor will vary directly with its armature voltage. They provide wide speed range, ease of speed setting and long, trouble-free operation. Simple modifications and control additions introduce further precision of control, controlled rates of acceleration and deceleration, and timed cycle operation.

Cooling water in order to maintain the accuracies required must be of sufficient flow and pressure to hold the fluid to 70 (plus or minus five deg.) F. Where the reciprocating engines were concerned, it didn't matter too much providing the temperature was held basically stable.

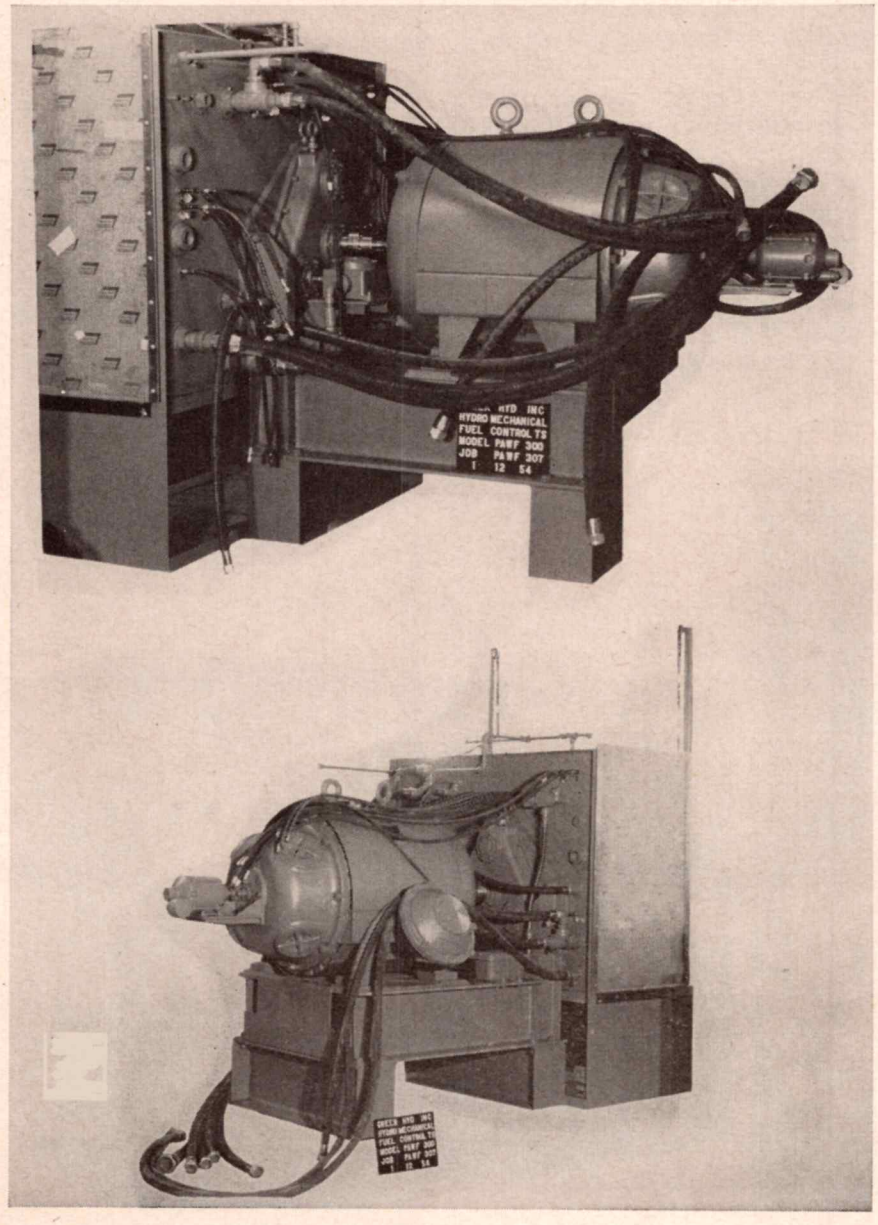
The new instrumentation must be extremely accurate. Automatic and precise recording is the general rule. Instrument calibration every 30 days is a necessary routine.

The above are basic requirements in the establishment of a



Power supply and reservoir of hydromechanical fuel control test stand

Views of drive stand structure of hydromechanical fuel control test stand

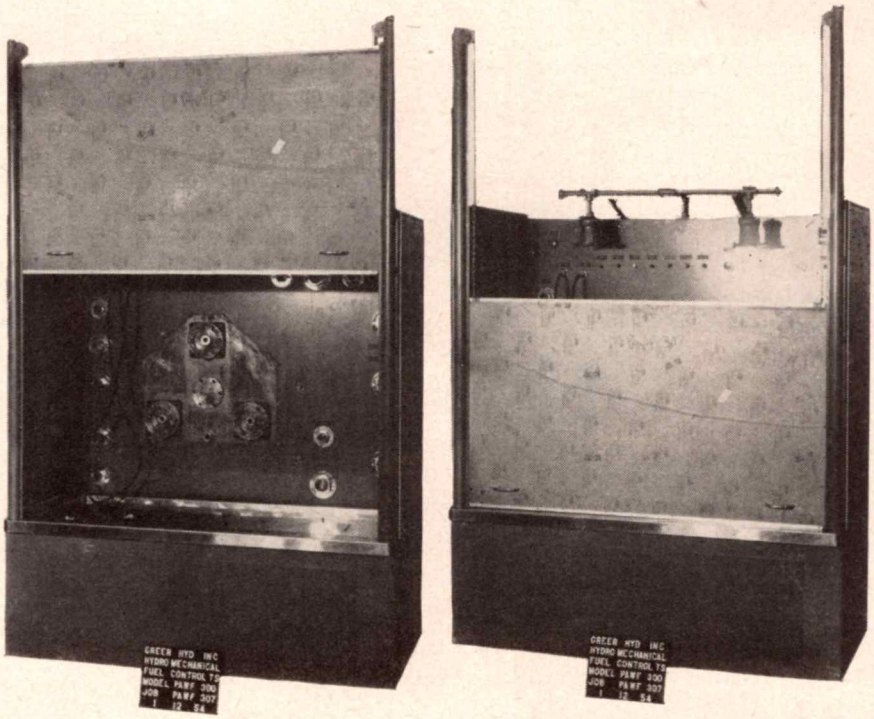


facility to correlate the results obtained by the accessory manufacturer, engine manufacturer and overhaul facility. Test equipment at these three facilities must have the same basic circuitry, the same accuracy, the same relative type of instrumentation and operating procedures.

The problem of adequate power, water and compressed air must also be considered. The accuracies demanded for testing gas turbine engine accessories are such that difficulties have often been experienced in locating the instruments, controls and components which must be used in the test stand. In many instances the instrumentation must have precision and accuracy over and beyond that of items being tested. Such components have to be newly created to satisfy the new art.

Most instrumentation and control manufacturers have been very cooperative in this way, although the present market for these items is very small.

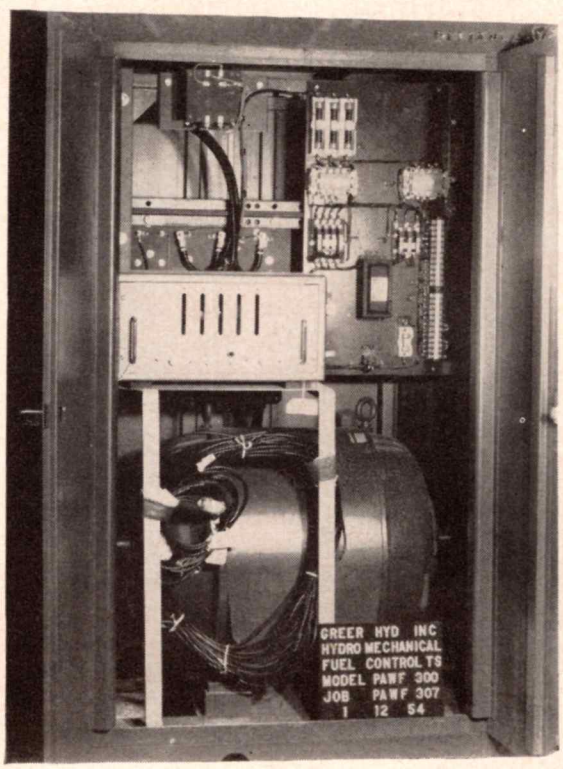
In view of the high power requirements and the extreme cost of the equipment, the problem of suitable protection for the personnel and the plant must be very carefully weighed. This factor must be studied to protect the



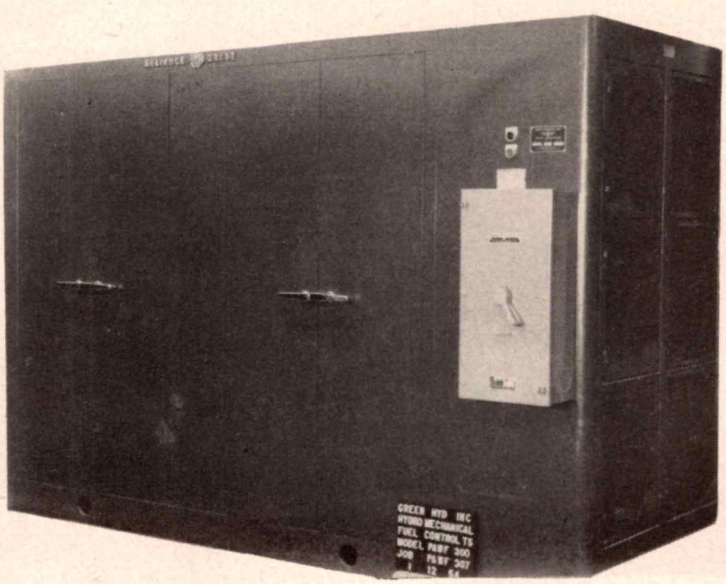
Drive stand structure of hydromechanical fuel control test stand

operator, consistent with production requirements, and at the same time assist the manufacturer in keeping his insurance rates at the lowest possible mark. To provide such protection, particularly on jet accessory test benches which are used for testing fuel system items, Plexiglass shrouds are employed to protect the operator in case of line failure. Carbon dioxide systems are also built into test stands so that they can be automatically or manually set into operation by the operator in case of fire. These provisions have heretofore not been provided in equipment, but the high flows and horsepower demanded in the near future make such features indispensable.

The flow requirements of test equipment have also imposed problems of storing large volumes of fuel. On reciprocating engines, the fuel tanks very rarely exceed 200 gal.; however, on turboprop and turbojet engines the pumping requirements are in many cases as high as 100,000 lb. per hr., or approximately 15,000 gal. per hr.

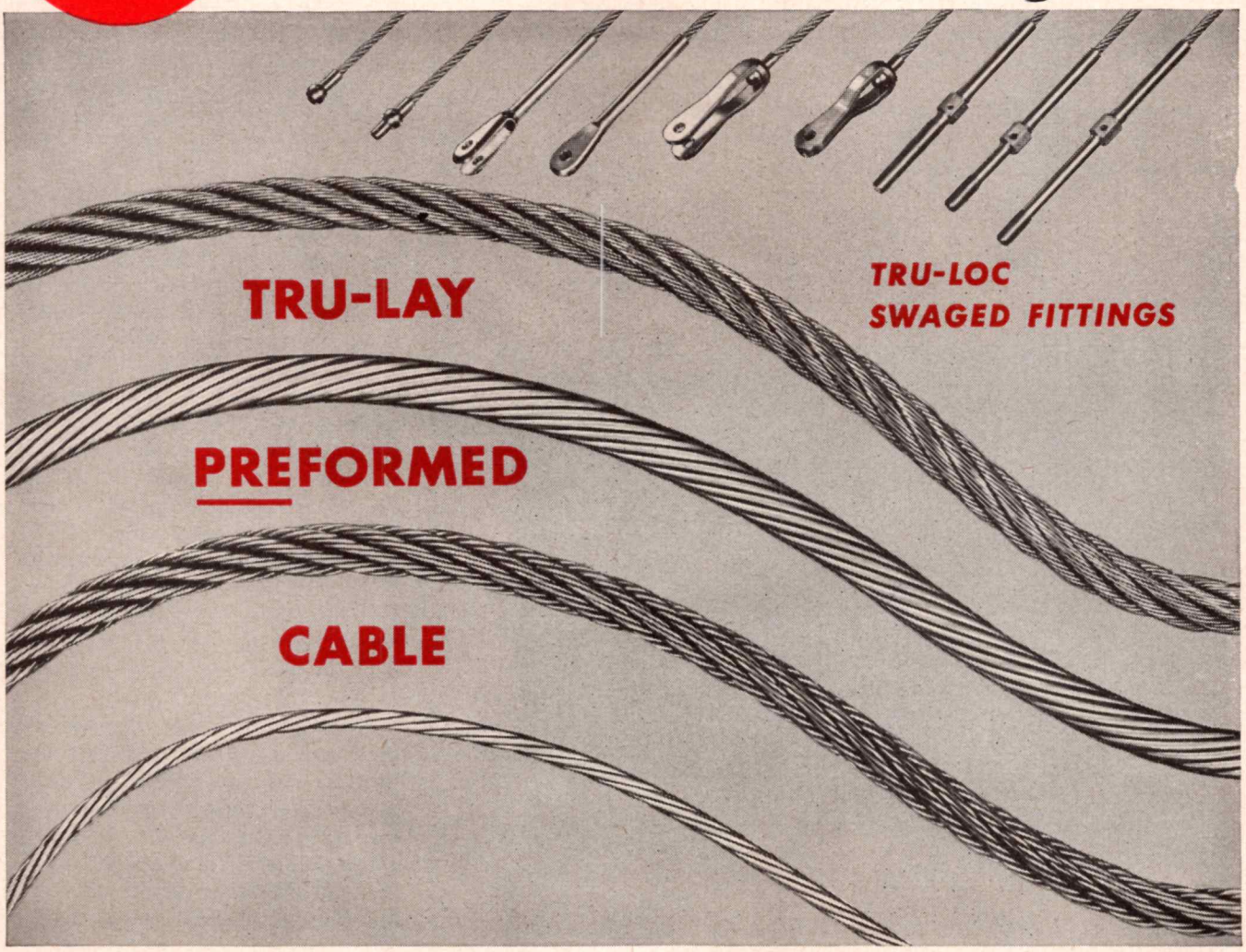


Reliance cabinet of hydromechanical fuel control test stand



ACCO products

TRU-LAY Cables TRU-LOC Fittings



Products the Aircraft Industry depends on...

ACCO, originators of preformed cable and strand and swaged terminals for aircraft cable use, has years of research and manufacturing experience in making these quality products for the aircraft industry.

You can specify them with confidence.

Tru-Lay cable, because it is preformed

- Can be cut without seizing.
- Is easier to handle—less tendency to loop or kink.
- Can be installed in less time.
- Makes possible the use of swaged terminals.
- Is free of tendency to rotate—runs true over sheaves or pulleys—is easier on pulleys.
- Has greatest resistance to bending fatigue—gives longer service.

Tru-Loc swaged fittings

- Guaranteed to hold to the rated breaking strength of the cable with which used.
- Designed and developed to eliminate the necessity for costly uncertain splicing.
- Provided in sleeve-type, ball-type, spherical, ball-with-strap, and Center-Pull loop fittings.
- "*Quickies*," — specially developed double-shank ball-type terminals—make it possible to connect and disconnect control sections in an instant without the use of tools.

ACCO TRADE MARK

Write Detroit office for specifications

Automotive and Aircraft Division

AMERICAN CHAIN & CABLE

601 Stephenson Bldg., Detroit 2 • 2216 So. Garfield Ave., Los Angeles 22 • Bridgeport 2, Conn.

Aircraft Cable • Swaged Fittings

This means that the fluid stored for immediate use must be kept cool and adequately protected. An aqua system may be provided to supply the desired fuel capacity from the farm system to the test cells to maintain daily fuel requirements plus an adequate reserve.

The space and facilities, as well as all the necessary temperature controls, pressure controls, pulsation dampers, are all-important in this type of system, insuring that the fuel delivered to the engine and accessories is under constant pressure and flow so that the thrust delivered will be within the guaranteed limits. Such results can be achieved only if each of the component test stands have accomplished the work required of them and the results have been correlated with the manufacturer.

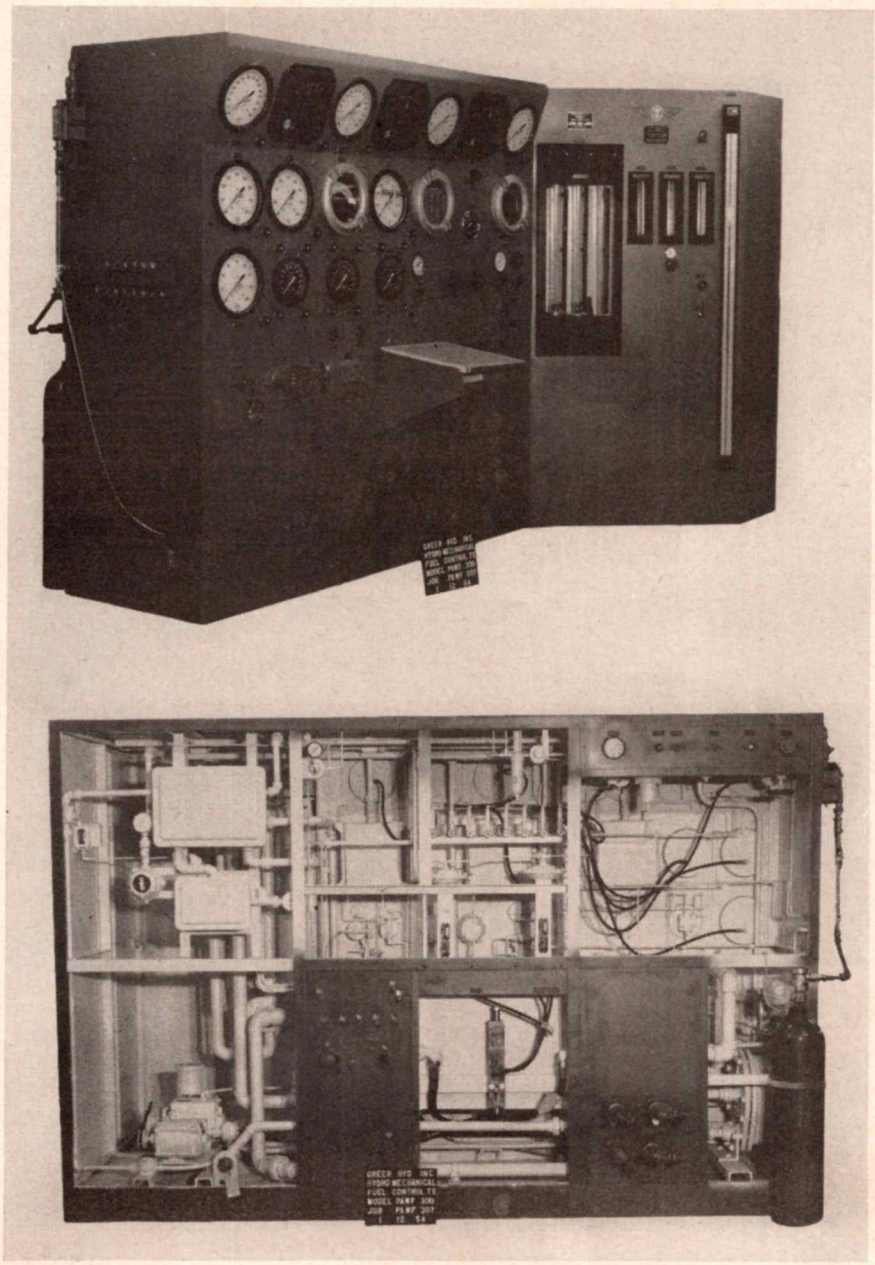
Another factor, heretofore not considered is the use of an afterburner with which air-driven accessories are used. An adequate air supply of at least three lb. of air per sec. between 700 and 900 deg. F. is required to test these accessories. Rigid manufacturer's specifications now necessitate the use of large air compressors suitably lagged and protected, the employment of boilers, or electrically employed heating elements, to heat the air for the afterburner controls, pumps and other air-driven accessories. At the present time, there are very few facilities which have available the requirements for accommodating air-driven turbo engine accessory components.

Coupled with this problem is the fact that many of these air driven devices rotate at speeds in excess of 12,000 rpm and up to 40,000 rpm. The resultant noise level is well in excess of what the human body can withstand for long periods of time. This means that the testing facilities for these components must be placed in soundproof rooms incorporating protection devices, carbon dioxide systems, remote operating controls and visual aids. These must operate with complete safety and simplicity and be capable of being easily maintained with ordinary tools.

It is obvious that the use of afterburners will increase, particularly for military application. Consequently, facilities developed must take into consideration the availability of suitable hot air in capacities and pressures capable of handling these turbo driven accessories.

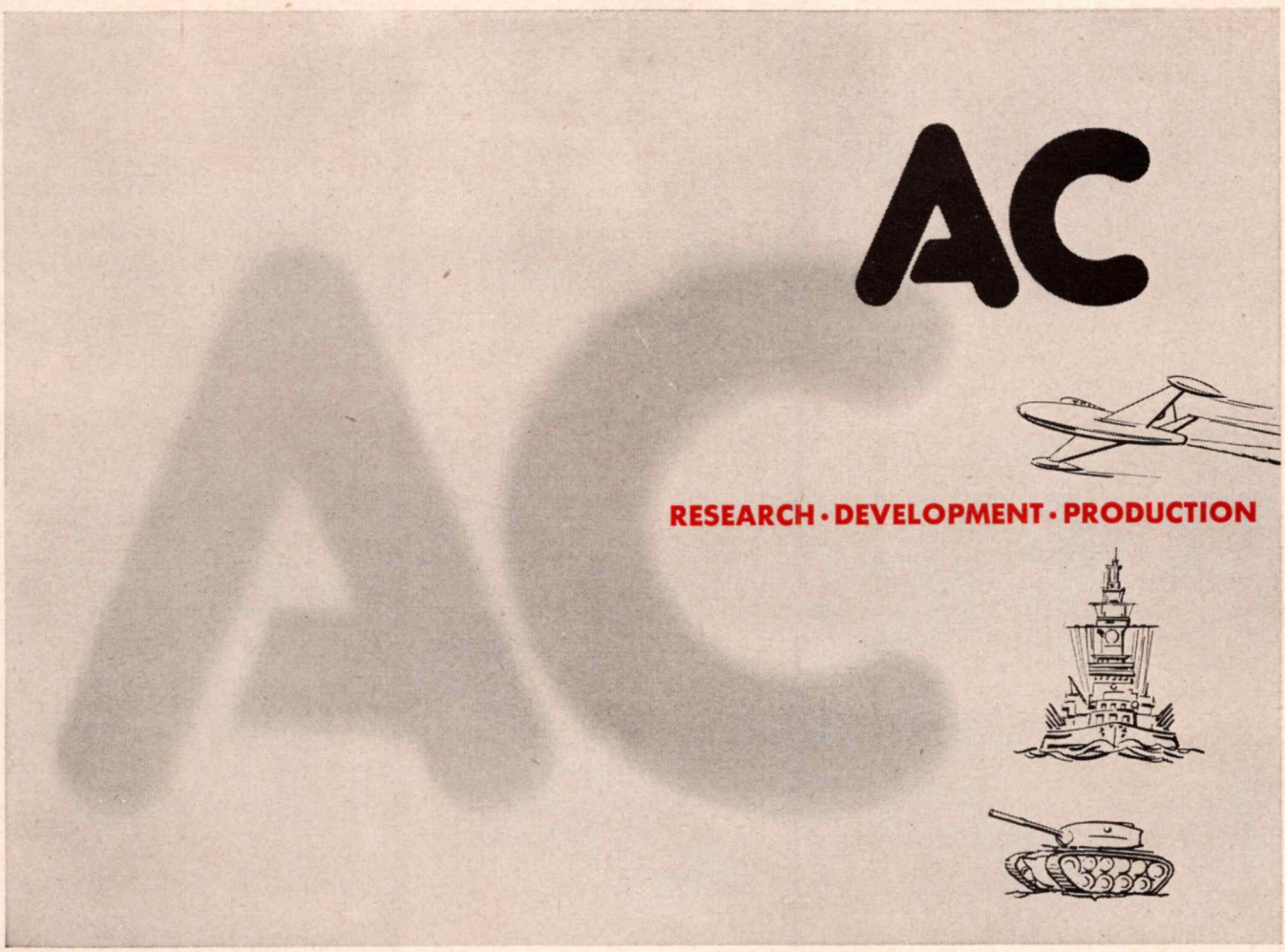
In setting up the test facility of the future it is obviously a mistake to attempt to convert existing reciprocating engine shops to handle gas turbine engines. At best they will be inadequate to handle the full production requirements of any type overhaul of the newer and larger accessories. The proper approach would be to furnish a new building with adequate space, built-in drainage system, suitable pipe lines to carry in the test fluid or fuel, adequate power, compressed air and cooling water by means of a separate cooling tower for the accessory building.

This radical approach means that future requirements can be taken into account at the start so that constant reconstruction will not be required. END



Main views of hydromechanical fuel control test stand

GOOD MEN and GOOD IDEAS } CAST LONG SHADOWS



AC DEFENSE PRODUCTS

AC SPARK PLUG DIVISION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN

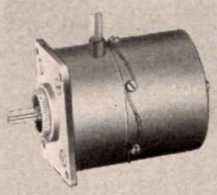
The effect of good ideas can be felt the length and breadth of the land—particularly ideas in research, development and production for defense.

Such ideas are rare. But, AC is proud of the many it has already contributed, and the part they have already played in America's defense through the T-38 Skysweeper, the A-4 Gun-Bomb-Rocket Sight, the Bombing Navigational Computer and others, many of which may not be mentioned here.

AC's people and AC's ideas have already cast a long shadow. But, this is only a beginning. The AC organization, with a group of more than 700 highly trained engineers, is rapidly forging to the very front of the electro-mechanical field.

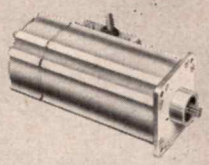
If you would like a hand with an electro-mechanical problem of your own, why not give AC a call?

DEFENSE PRODUCTS of High Quality at Low Cost DELIVERED ON TIME

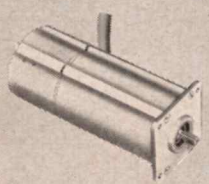


Fast action clutch-brake of unique Lear design utilizing two opposing coils to force clutching and declutching. Increases the speed of both operations. Typical application: digital mechanical computor.

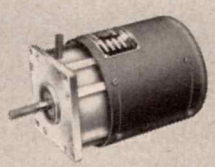
Specially designed Lear motor utilizing offset gear train to allow close tolerance between mounting surface and output shaft. Typical application: aircraft scavenger pump.



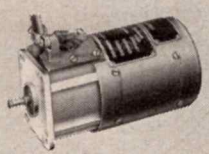
Lear intermittent duty AC motor. Has high torque AC brake capable of stopping both rotor and connected inertia load. Typical application: positioning actuator for jet engine air intake doors.



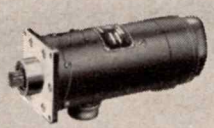
Lear AC brake motor with exceptional environmental resistance. Non-corrosive materials used throughout, including laminations. Typical application: aileron trim tab actuation.



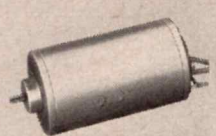
AC motor of the air-over-totally-enclosed type. Has special mylar high dielectric insulation. Typical application: hydraulic pumps.



Synchronous AC motor. Has exceptional high starting torque which overcomes starting drag characteristics. Provides optimum low temperature operation. Typical application: radar scanning device.

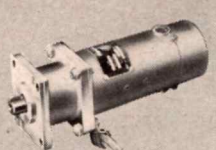


DC intermittent duty motor incorporating Lear Fastop Clutch. Extensively used for heavy duty. Typical application: cowl flap power unit.

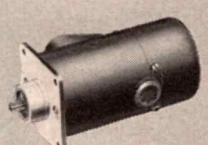


Miniature DC motor. Unusual specifications required armature which could be stalled continuously and a field to match 10,000 ohm impedance of vacuum tube amplifier. Typical application: trim tab servo.

Lear DC motor with noise filter designed integrally into special pump base. Totally enclosed and self-ventilated. Typical application: pumps.



Gearhead DC motor. Demonstrates building block flexibility. Gearhead components are available in a variety of gear ratios for all Lear motors. Typical application: guided missile fin actuation.



DC brake motor with quick stopping and high holding torque. Optional thermal protection. Typical application: seat actuator.

SALES OFFICES—Grand Rapids: 110 Ionia Ave., N.W. ★ **Los Angeles:** 11916 W. Pico Blvd. ★ **Westbury, L.I., N.Y.:** 578 Grand Blvd. ★ **Wichita:** 307½ Laura St. ★ **Fort Worth:** 6100 Camp Bowie Blvd.

Motors by the Million

...and all of aircraft quality!

Although Lear's production of electric aircraft motors impresses by its magnitude, the major emphasis is first, last, and always upon ***quality.*** It is doubtful that any other company invests as much engineering time into every motor it builds. An entire, top-calibre engineering department is devoted exclusively to motor design, making Lear exceptionally qualified to handle the more exacting and difficult applications which most manufacturers hesitate to tackle.

Lear's excellent ***facilities*** for the design, engineering, production, and testing of motors are devoted to building *aircraft* motors and aircraft motors alone. Lear motors are designed to meet every applicable military specification.

Lear has accumulated immense ***experience*** in the manufacture of motors of aircraft quality, having built over one million since 1941. All motors used on precision Lear equipment such as electro-mechanical actuators, vertical gyro indicator systems, and F-5 autopilots, are Lear motors, so they *have* to be good.

Lear is an acknowledged leader in the field of motor noise ***filtering.*** Noise filters are engineered into Lear motors at the design stage — not added as an afterthought when the product is finished — thus providing substantial savings in weight and space, and tangible bonuses in performance.

Lear motors achieved early prominence through the use of the Lear "Fastop" clutch, and are now available with a complete line of ***braking*** devices, including both AC and DC brakes of the single-disk and multiple-disk types (which incidentally, are offered as separate components to other manufacturers).

Although all Lear motors are new ***designs,*** an infinite variety of additional models are available through combination of arrangements used in our regular families of motors, of which only a small part are illustrated here. Thus, Lear-quality models can be designed, and are designed, to meet practically any specialized requirement.

If you need any kind of an aircraft electrical motor — and if you want the best — it will pay you to consult Lear. Write, wire, or phone your nearest Lear Sales Office or Lear, Inc., 110 Ionia Avenue, Grand Rapids 2, Michigan.

Gearhead DC motor. Continuous duty, air-over-totally-enclosed type with single stage reduction spur gearing and built-in filter. Typical application: aircraft fuel pump.

LEAR GRAND RAPIDS DIVISION

EM-5

Wash., D.C.: 1701 K St., N.W. ★ **San Diego:** 429 Robinson Ave. ★ **Dayton:** 53 Park Ave. ★ **Seattle:** Term'l Bldg., Boeing Field ★ **Toronto, Ont. and Montreal, P.Q.:** Railway & Power Engr. Corp., Ltd.

Automatic Temperature Controls for Aircraft

By FRANK GLASSOW, Chief Development Engineer

W. F. TICE, Sales Manager
Barber-Colman Co.

Design problems, new techniques and ultimate goals outlined for future

THE rapid advances in increased speeds and performance factors of modern gas turbine powered aircraft have necessitated corresponding changes in equipment design by the manufacturers of automatic temperature control equipment. Because of the high capacity of present heating and cooling equipment, excessive cockpit temperature would result without proper control. The use of fast acting automatic controls is imperative since the heating and cooling demands can vary rapidly over wide ranges.

In a typical fighter, a dive from 45,000 ft. to sea level can be accomplished in 135 sec. In this interval the cabin external heat load may change from a requirement of 10,000 BTU per hour of heating to 12,600 BTU per hour of refrigeration. Unless prompt action were taken by the control system, a cabin temperature of 225 deg. F. could result. The control problem is also more difficult because of the increasingly stringent weight and space requirements for auxiliary equipment.

The problem of control system design is by no means simplified by the adverse environmental conditions surrounding the control

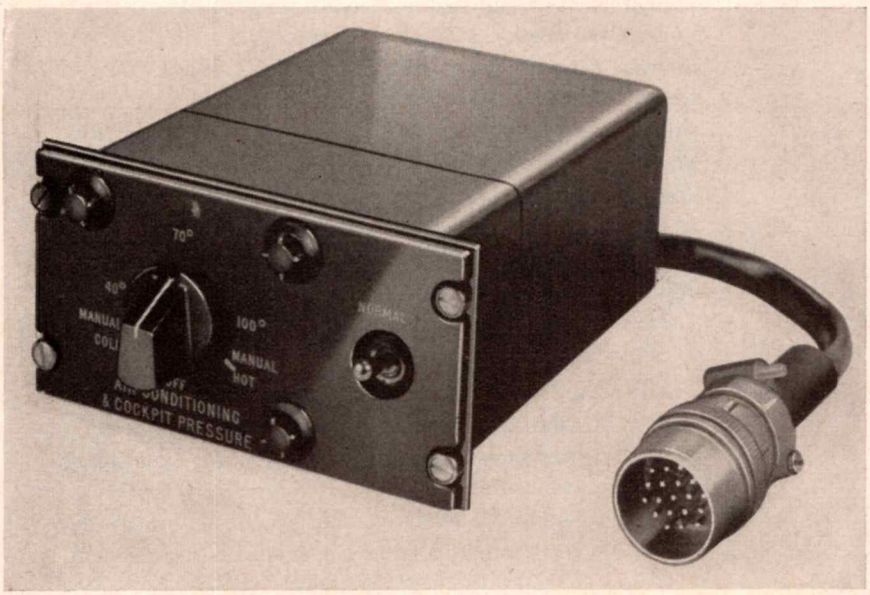


Fig. 1 A typical electronic control assembly

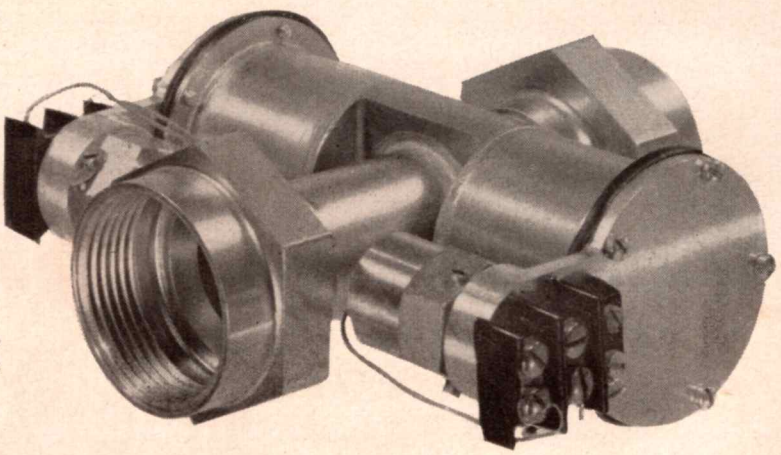


Fig. 2 Valve example of weight reductions by using pneumatics

AIR-TURBINE DRIVES by *Eclipse-Pioneer*

Country's most complete facility for research and development of air-turbine-driven equipment.

ADD

to ***PERFORMANCE***

... RELIABILITY

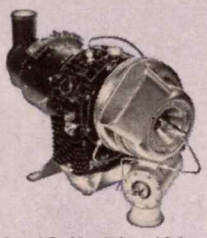
... VERSATILITY

SUBTRACT

from ***WEIGHT***

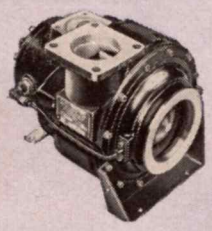
... COST

... MAINTENANCE

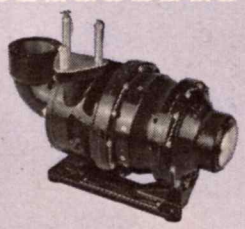


Constant-Speed Turbine-Driven AC Generators

Air-Turbine Starters

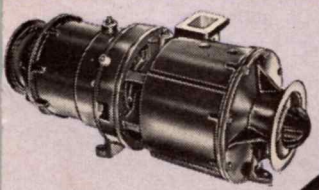


Turbine-Driven Fuel or Water-Alcohol Pumps



Turbine-Driven Ram-Jet Fuel Pumps

plus many other turbine-driven accessories



...rbine-Driven Cabin Air Compressors

Have you considered the advantages of driving your air frame and engine accessories by air?

Compared to other existing drive systems, Eclipse-Pioneer Air-Turbine-Driven units . . . including constant-speed drives . . . cost less and save up to 50% in weight. As desired, they can be supplied for mounting directly on the engine or at some remote location to suit space limitations. Relative simplicity of design permits replacement in minutes, and faster and cheaper overhaul.

E-P's air-turbine program is complete and covers a wide variety of functions, including ram air and engine-bleed, air-driven applications. And even as the most advanced units roll off the production line, research and development continue with vigor . . . investigating the practicability of bleed and burn systems . . . improving on limits of speed control . . . producing greater output in smaller packages.

With close to 40 years of specialized aviation accessory experience, we *know* the accessory business. And because we *know* accessories, we design and build our turbine drives with accessory requirements always firmly in mind.

Whether your requirements call for an accessory with integral air-turbine drive, or an air-turbine drive by itself, E-P can suit your needs precisely. Write today for further information and for illustrated brochure, "Air-Turbine Facility".

Eclipse-Pioneer

TETERBORO, NEW JERSEY • DIVISION OF Bendix AVIATION CORPORATION

West Coast Office: 117 E. Providencia, Burbank, Calif.
Export Sales: Bendix International Division
205 E. 42nd St., New York 17, N. Y.

... world's largest producer of aviation instruments and accessories

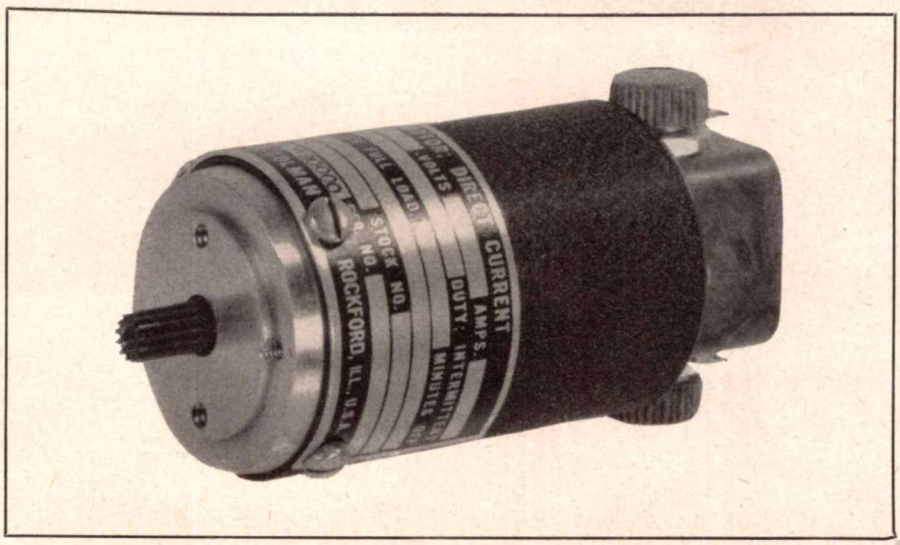
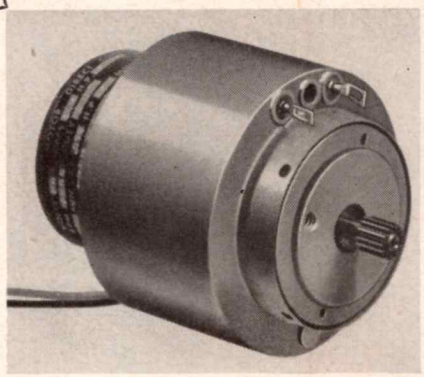


Fig. 3 Small actuator motor illustrating typical new-style plastics application

Fig. 4 Another example of design reducing envelop size in an electro-mechanical actuator



components. The wide range of ambient temperatures, increased by dissipation from the equipment itself, creates problems in selection of components and reduces the life, efficiency, and stability of nearly all components. Protection from shock and vibration creates design problems in layout and mounting. Military requirements with respect to sand and dust, humidity, fungus, and salt spray protection necessitate packaging techniques which are, in general, not conducive to a high rate of heat transfer.

In solving all these design problems, a high degree of reliability must be maintained and at the same time size and weight must be kept to a minimum. During the next several years, when the airlines will be placing jet transport aircraft into service, it will become increasingly more important that the components of the accessory systems be designed for ease of maintenance, simple construction, and reliable service.

In the field of automatic temperature control, the trend has been toward increased use of electronic or pneumatic systems to provide fast response to temperature variations detected by the temperature sensing elements of the system. Pneumatic and electrical equipment also have been combined to perform functions that formerly were primarily electromechanical. The large source of compressed air provided by jet engine compressor bleed has encouraged this trend.

A typical electronic control assembly, shown in Fig. 1, is capable of maintaining the cockpit temperature within half a degree at any selected temperature in the range of 40 to 100 deg. F. In addition, this control box also provides automatic duct high limit protection. The control assembly is designed as an integral part of the cockpit instrument panel. It has been estimated that by combining the selector rheostat and override switches as part of this unit, nearly three lb. of cable, connectors, and brackets were eliminated which would otherwise have been necessary if the components were individually and remotely installed. The complete automatic temperature control system supplied for the lightweight jet fighter using this assembly weighed less than one-half of the lightest of its predecessors supplied for earlier fighters.

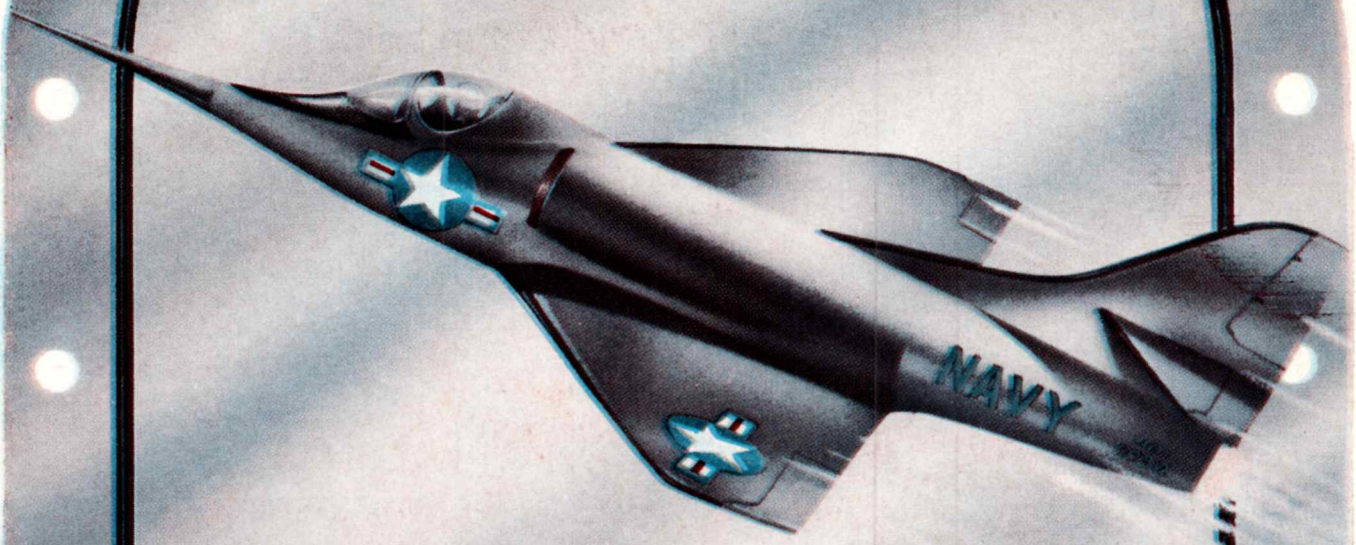
The valve illustrated in Fig. 2 is a typical example of weight reductions by use of pneumatics. Small solenoid pilot valves on this unit control the position of a piston in a pneumatic cylinder, which operates the air conditioning or air shut-off valve. Since power is obtained from the high pressure carried within the valve itself, an integral bleed port can be used, making pneumatic lines unnecessary. Judicious design has resulted in the use of only a very small amount of air while the valve is being moved. Weight saving results from the elimination of generous amounts of copper wire, magnetic steel, bearings, gears and castings commonly used in electro-mechanical actuators. The solenoid valves require only a fraction of the power consumed by an electric motor. Since no bearings are contained in the pilot valves or pneumatic cylinder, lubrication is not a problem. Therefore, the combination is capable of operating in higher ambient temperatures than are possible with most electric motors.

The increased flight speeds and high operating temperatures of modern engines dictate the use of materials which will withstand many times the maximum temperatures of a few years ago. The electro-pneumatic valve described above consists mainly of stainless steel with nicro-brazed joints. This construction permits the valve to carry 850 deg. F. air at high pressure. Other valves are made with precision castings of stainless steel.

Wherever electrical control components are used, non-metallic materials are necessary in the form of electrical insulation. Noteworthy strides have been made to provide material suitable for high temperatures. The designer is now able to choose from a variety of new plas-

on the Douglas "MIGHTY MIDGET," too . . .

Gask-O-Seal access doors



The Navy's new A4D by Douglas is framed above against the Gask-O-Seal configuration chosen for the ship's wing access doors. Like the Mighty Midget itself Gask-O-Seals are a new engineering-design conception. They achieve zero leakage of access doors, flanges, hand-hole covers and similar devices where positive, safe sealing is imperative . . . another sealing design by the Franklin C. Wolfe Company, makers of Lock-O-Seal, Gask-O-Seal, Riv-O-Seal and other sealing devices for sealing fasteners, fittings, etc. If your designs demand safe, sure sealing, please write for our catalog "Designed for Sealing."

FRANKLIN C. WOLFE CO., INC.

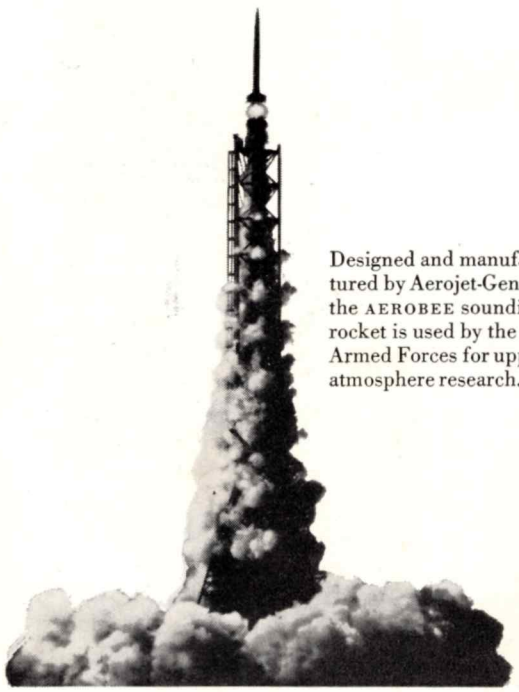
3644 Eastham Dr. Culver City, Calif.

Telephone: TExas 0-4618

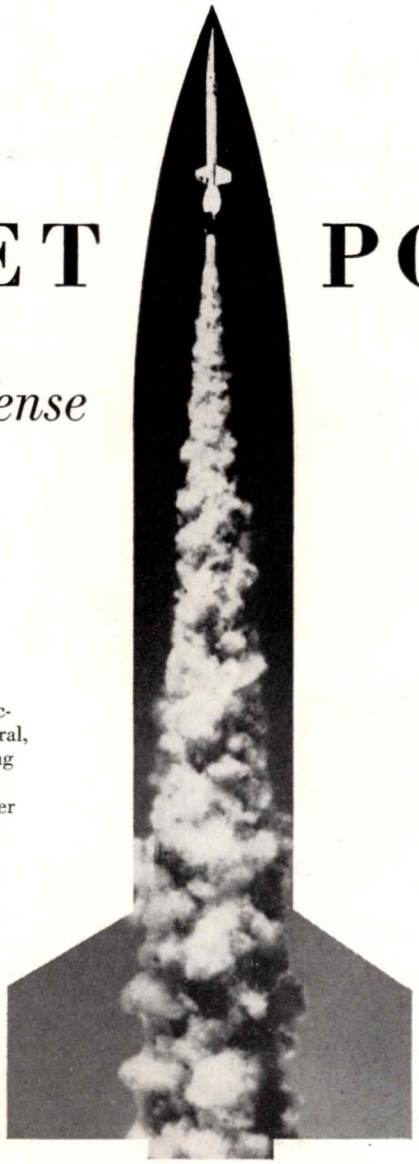
"Sealing Design Specialist"

ROCKET POWER

for Land-Sea-Air Defense

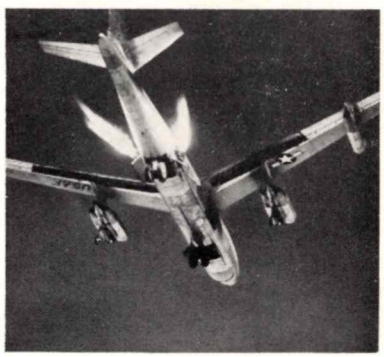


Designed and manufactured by Aerojet-General, the AEROBEE sounding rocket is used by the Armed Forces for upper atmosphere research.



The Navy's P2V takes off with the aid of Aerojet-General smokeless JATOs.

Originator of JATO, Aerojet-General has produced more than 300,000 for assisted takeoff of piloted aircraft.



Aerojet-General liquid-propellant rocket powerplants permit increased payload for Air Force Boeing B-47B jet bomber.

Aerojet-General has developed and manufactured rocket powerplants for guided missiles and piloted aircraft since awarded its first contract by the Armed Forces early in World War II.

Successful performance of its rocket engines, missile boosters, ordnance weapons and auxiliary powerplants of many types has earned Aerojet-General's reputation for rocket dependability.

Aerojet-General's production facilities, including its 14,000-acre plant site near Sacramento, guarantee low-cost, on-time delivery of rocket powerplants of any size and in any quantity.

Aerojet-General

CORPORATION

A SUBSIDIARY OF
THE GENERAL TIRE & RUBBER COMPANY

THE GENERAL TIRE

AZUSA, CALIFORNIA
CINCINNATI, OHIO
SACRAMENTO, CALIFORNIA

Aerojet-General needs:

Chemists
Electronic Engineers
Mechanical Engineers

SOLID AND LIQUID PROPELLANT ROCKET POWERPLANTS FOR MISSILE AND AIRCRAFT APPLICATIONS

THRUST REVERSERS (SNECMA)

AUXILIARY POWER UNITS AND GAS GENERATORS

ELECTRONICS AND GUIDANCE

ORDNANCE ROCKETS

EXPLOSIVE ORDNANCE AND WARHEADS

UNDERWATER PROPULSION DEVICES

ARCHITECT-ENGINEER SERVICES FOR TEST FACILITIES

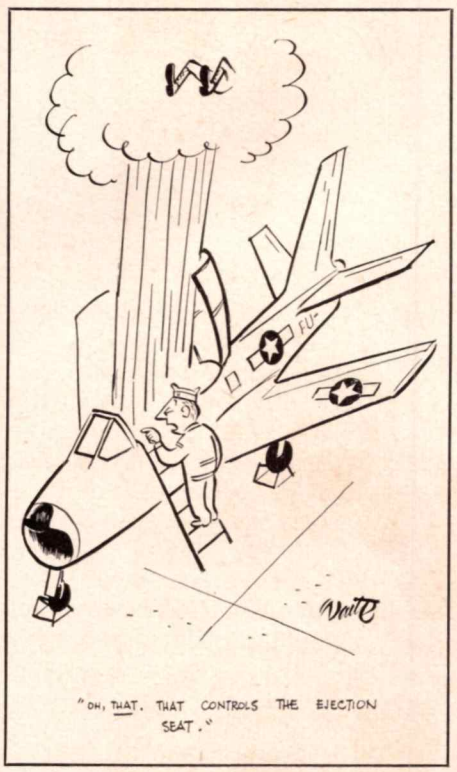
tics to obtain molded parts which can endure 500 deg. F. ambient temperature for prolonged periods. A typical example appears in the small actuator motor illustrated in Fig. 3. The phenolic end cap which insulates the brush structure is Fiberglas filled phenolic having excellent dimensional stability, extreme toughness and remarkable heat resistance. Windings in the motor are silicone enameled and are insulated from magnetic steel by thin sheets of silicone impregnated Fiberglas. The windings are also treated with a silicone impregnating varnish. The combined result is a motor which will withstand unusually high ambient and operating temperatures; the primary limitation is the bearing lubricant.

To keep pace with the trend toward higher temperatures, lubricants are needed for bearings, gears, and screw jacks for the range of —65 F. to 500 deg. F. and higher. Due to the severity of the lubrication problem at elevated temperatures, designers of high performance, high temperature aircraft accessories are obliged to concentrate on means of eliminating complex mechanisms utilizing conventional lubricants in favor of simpler mechanisms such as the pneumatically powered control valve described herein.

Fig. 4 illustrates another example of design engineers' efforts to reduce the envelope size of an electro-mechanical actuator. The radio noise filter has been constructed in a toroidal shape to slip over the actuator drive motor. This eliminates special brackets or housings previously required for the filter. The new filter also offers improved performance in accordance with military specifications.

During the past 10 or 15 yrs., the testing facilities of accessory manufacturers have expanded many fold. A few years ago it was customary for control system components to be tested in a prototype aircraft. More recently, aircraft control systems are tested in mockups for overall performance; components are tested to the applicable environmental extremes and performance requirements well in advance of aircraft installation. The value of such test facilities is even more evident when it is realized that some aircraft manufacturers estimate flight testing cost as high as $20,000 per hr.

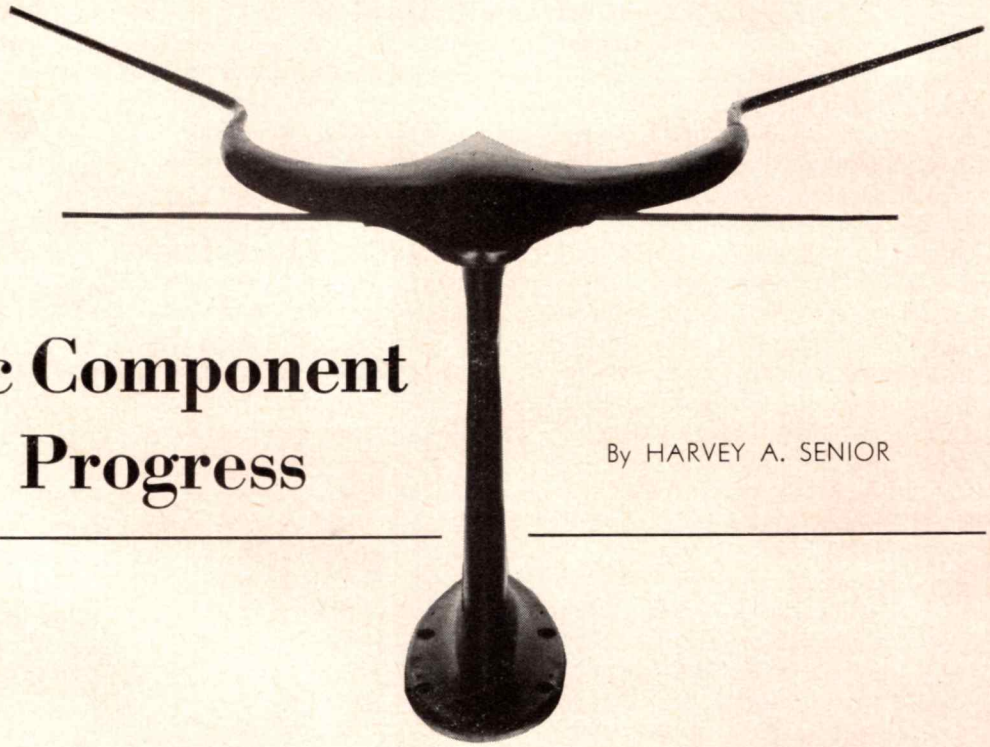
Among the special tools available for evaluating the design of new temperature control systems is the analog computer. To analyze the performance of the complete system, the characteristics of each piece of equipment are determined and expressed in terms of a mathematical formula. An electrical counterpart for the system can be set up since in many cases the action of electrical components such as resistors and capacitors can be expressed by the same mathematical formula. For example, electrical charge is analagous to the amount of heat (BTU) in the actual system. The movement of this charge, or electrical current, then corresponds to the air flow of the actual system which carries heat from one point to another.



The voltage at any point in the electrical analogy corresponds to the temperature at the corresponding point of the actual system. Capacitors in the electrical system, which are used to store electrical charge, are similar in their characteristics to the thermal mass of the actual system; and electrical resistance, which tends to resist the flow of electrical charge, corresponds to the thermal insulation of the actual system. Resistors and capacitors can be combined in the electrical analogy to control the rate of change of voltage at a given point and thus can be used to simulate thermal response of the actual system. By taking advantage of physical laws such as the above, it is possible to set up an electrical circuit which will perform in practically the same way as the mechanical system which it represents.

The operation of the system is evaluated in the computer approach by reading the voltage (which corresponds to temperature) at a point corresponding to the cockpit. Since it is usually desired to determine the dynamic characteristics of the system, a continuous strip chart recorder is used to show the voltage variations and to make a permanent record for detailed study. The advantage of the computer over a mechanical mockup of an actual system is that various factors can be readily changed merely by changing the electrical components in the circuit, whereas the mechanical counterpart would require considerable time and effort to make a similar change.

In the development of new systems and components, reliability and simplicity of maintenance are paramount factors which cannot be compromised in spite of the trends toward miniaturization. Unnecessarily complicated devices impose a handicap on the ability of the airlines and Air Force to keep airplanes in operation. Moreover, a failure of a single portion of a component or system should not cause progressive failures of other related parts. To accomplish these objectives, it is increasingly necessary that close cooperation be maintained between the suppliers of accessory equipment and the aircraft manufacturers, all through the preliminary engineering development, and qualification testing programs. This sort of technical teamwork will undoubtedly benefit both the airframe and component manufacturer and is essential to the maintenance of satisfactory progress in the face of the severe requirements now imposed upon both airframe and accessories. END



Electronic Component Design Progress

By HARVEY A. SENIOR

ANALYSIS of almost any complex device will reveal that its final form has evolved along a series of compromises. The aircraft radio designer concerned with a new receiver must choose between mechanical versus electrical remote control, crystal versus tunable frequency control, and a host of similar resolutions in order to achieve the best configuration for his design objectives.

The designer has several basic "building blocks" — fundamental shapes, components and circuits, conceived and perfected by the patient researcher in his laboratory —at his command. Each "block" will have certain inherent advantages and disadvantages. The designer selects those blocks having the most advantages and the least disadvantages for the purpose at hand. Efficiency and overall utility of the final design is directly related to the ingenuity of the designer in arriving at a combination of blocks having the greatest number of advantages with the least number of disadvantages.

Lightest weight consistent with utmost reliability have long been watchwords of the aviation industry. Aircraft Radio Corp. has hewed close to the line of these basic objectives by creating units of inherent design simplicity, by using quality components. The general tendency in the field of aircraft radio receiver and transmitter design has been to provide more and more frequency channels, and to permit selection of any desired channel by means of an automatic remote control system. Aircraft Radio has remained firm in creating transmitters having a small number of frequency channels and tunable receivers having a simple mechanical control system.

With regard to navigational receiving equipment, ARC feels that the tunable receiver possesses so many advantages that a direct comparison is hardly possible. In the tunable receiver, one has at his fingertips all stations which are transmitting a signal at any given moment within the range of the receiver. He need not fuss around with a cockpit full of charts in order to find the particular frequency that he is seeking. Use of a tunable receiver requires an aural check of omni station or other navigation facility identification, which in itself is a safety factor.

Approximately 30 sec. is required to tune the receiver from one end of the band to the other, and the pilot will hear each station as he tunes through it. With the push button type equipment, some 22 min. would be required to channel each of the various frequencies involved, and in the event the pilot lost his charts, he would be forced to go through this process in order to locate the station desired.

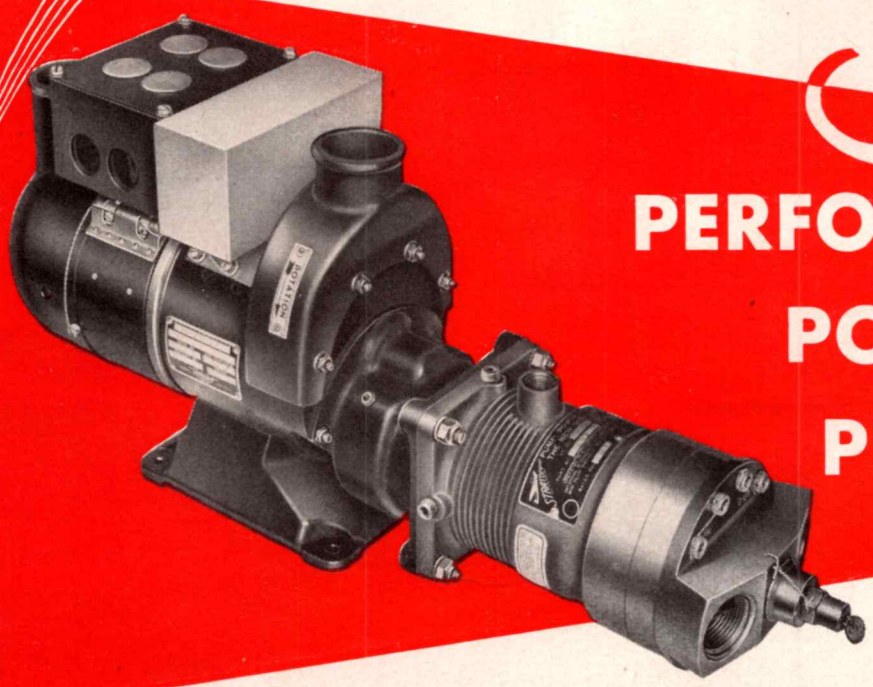
The Federal Communications Commission requires that all transmitters be crystal controlled. Each ARC VHF transmitter weighs 3.4 lb. complete with crystals and shock mounting, and provides five crystal-controlled frequencies within a two-megacycle spread. It is possible to obtain, say, fifteen channels in three transmitters at a cost in weight of 10.2 lb. As many of

Industry offers building blocks for assembly of versatile communication systems

STRATOPOWER

ELECTRIC MOTOR DRIVEN HYDRAULIC PUMPS GIVE YOU ALL 3

PERFORMANCE • POWER • PRICE



Performance is the main consideration in these sources of emergency or auxiliary hydraulic power. And, STRATOPOWER provides this proved dependable performance with over 30 models now in use. There are constant and variable delivery pumps with capacities from ¼ to 16 gpm . . . pressures to 3000 psi . . . AC and DC motors to meet your current requirements for continuous or intermittent duty . . . Lots of power in the minimum amount of space and weight . . . and at minimum cost.

STRATOPOWER Electric Motor Driven Hydraulic Pumps make it possible to provide safety in event of power failure or malfunction of the main hydraulic system. They may be located remote from the engine, making accessory drives available for other equipment. This flexibility of location provides an obvious means for reducing the length and vulnerability of hydraulic lines.

Used as an auxiliary power source, these STRATOPOWER units provide the additional capacity required during periods of heavy demand on the main system. Or, they may be used on the ground for hydraulic power when engines are not running, or for testing the plane's hydraulic system.

Write for complete information on STRATOPOWER Electric Motor Driven Hydraulic Pumps today.

WATERTOWN DIVISION
THE NEW YORK AIR BRAKE COMPANY
STARBUCK AVENUE • WATERTOWN • N. Y.

WATERTOWN DIVISION
The New York Air Brake Company
745 Starbuck Ave., Watertown, N. Y.

Please send me full information on STRATOPOWER Electric Motor Driven Hydraulic Pumps to deliver ___

Name_____

Address_____

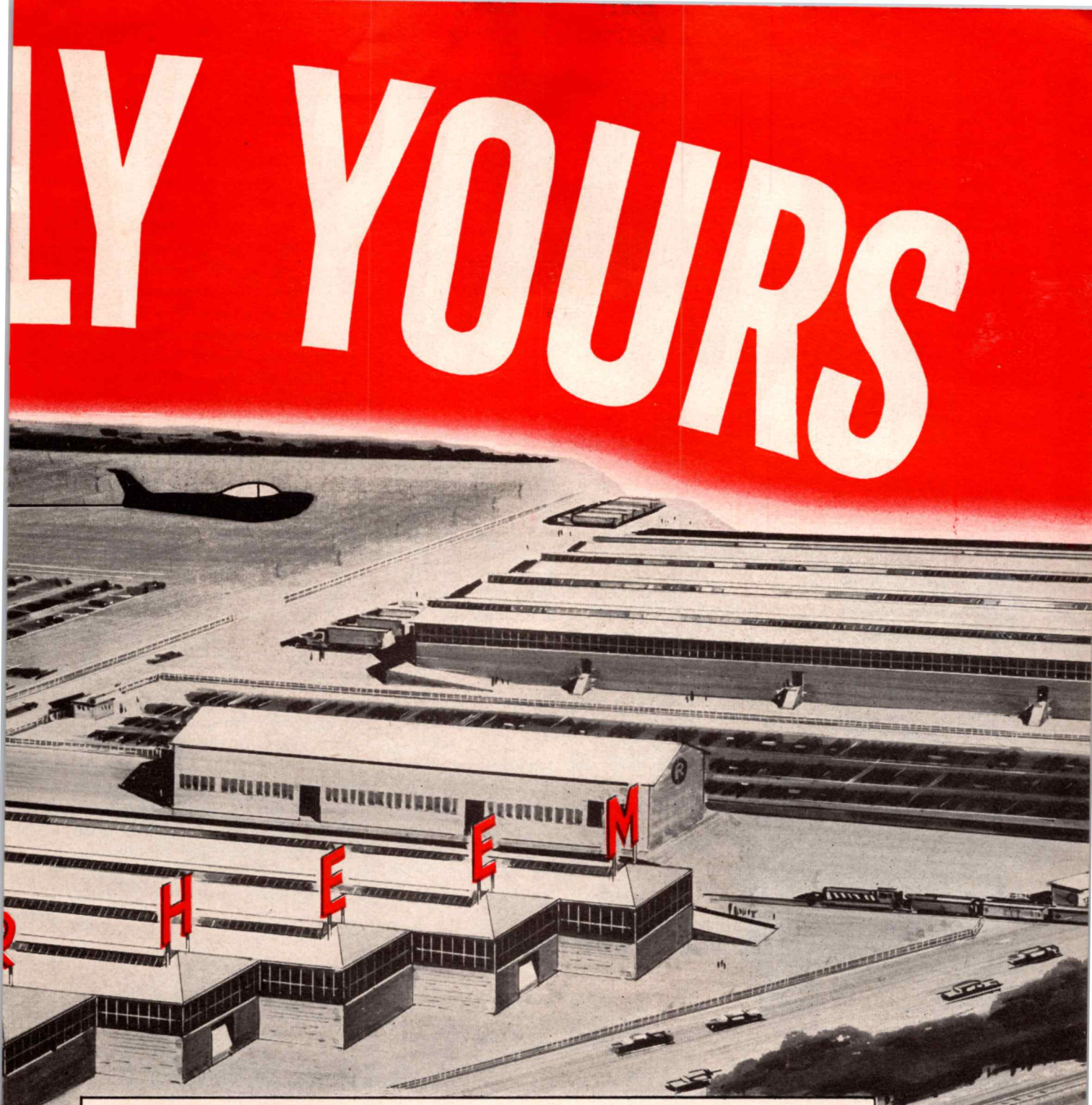
City_____ Zone____ State_____

EXCLUSIVE

Rheem

AVIATION DIVISION

LY YOURS



This immense plant is devoted *exclusively* to *government* research . . . engineering . . . and production. Present projects include the production of air frames, missile components, jet engine components, airborne ordnance and electronics.

Plant facilities cover nearly one-half million square feet of floor space on 50 acres of ground. These outstanding facilities constitute a major industrial investment in national security . . . and are completely at your disposal. Write, wire or phone for full details.

RHEEM Manufacturing Company • Government Products Division, Downey, California

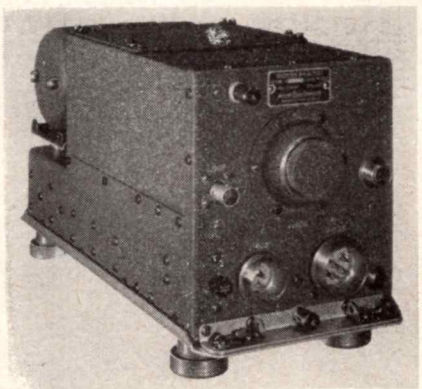
these transmitters may be multiplied as may be necessary in order to provide the user with adequate channels for the particular operation of his aircraft as is required.

The high-voltage power for the transmitter (s) is obtained from the dynamotor on any of ARC's LF or VHF receivers. There is never more than one transmitter in operation at one time. Normally, the VHF communication or navigational receiver supplies this power. In the interest of reliability, one transmitter is usually designated emergency and is powered from a second VHF or a LF receiver. Installation of a second omni receiver for simultaneous reception of two omni stations is fast becoming a must on larger aircraft.

VHF Navigation

The ARC Type 15D VHF navigation equipment has the following units: R-13B receiver, B-13 converter, C-22A control unit,

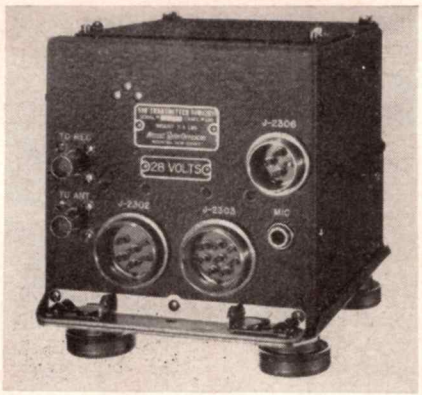
One of latest receiver designs



15463 course selector, 13310 cross-pointer meter, A-13B antenna and necessary connecting plugs.

A dual E-14 rack supports the R-13B receiver and the B-13 converter, and also acts as a junction box for all other units. An M-10 mounting serves to shock mount and to attach the rack and its contents to structure.

The R-13B receiver is a tunable unit for reception of amplitude-modulated signals in the 108-135 mc. band. It is a nine-tube superheterodyne using a four-section gang condenser in the rf section and eight tuned circuits at 15 mc in the if section. The rf oscillator frequency is below the dial frequency. A noise-limiter and two stages of af follow the detector. Output to the converter is taken from the first af stage and is unaffected by headset load.



Aircraft Radio VHF transmitter

Automatic volume control is the delayed type. Particular attention has been paid in the receiver design to keep spurious responses to a minimum. The af amplifier has been designed to cut off signals at the low and the high ends of the af spectrum. This eliminates unnecessary listening to the portions of the signal required for visual navigation.

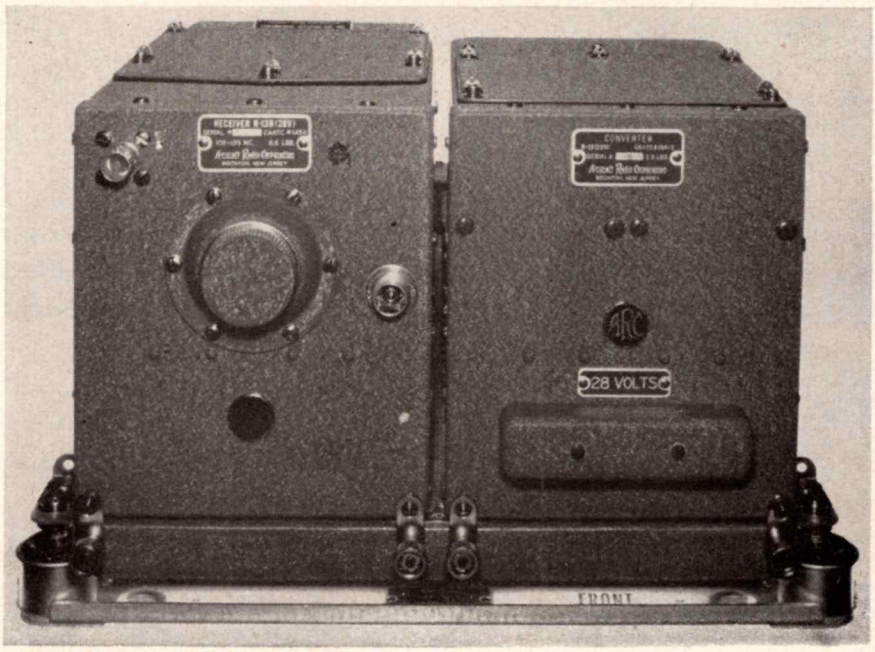
Considerable attention has been paid to the stability of tuning. The result is that for temperature changes from 50 deg. C. to minus 30 deg. C., at any frequency in the band, from three minutes after turning on the set at the time of maximum drift, the tuning shift does not exceed 0.04 percent.

The function of the Type B-13 converter in receiving VOR omni signals is to take the complex audio frequency signal voltage from the cathode of the first af stage in the receiver and to convert and interpret the signal in such a way that the bearing of the receiving antenna from the transmitting antenna is determined. The af signal has two independent components. One is 30 cps known as the "variable channel" signal whose phase in space at any given instant is a function of the bearing from the transmitter.

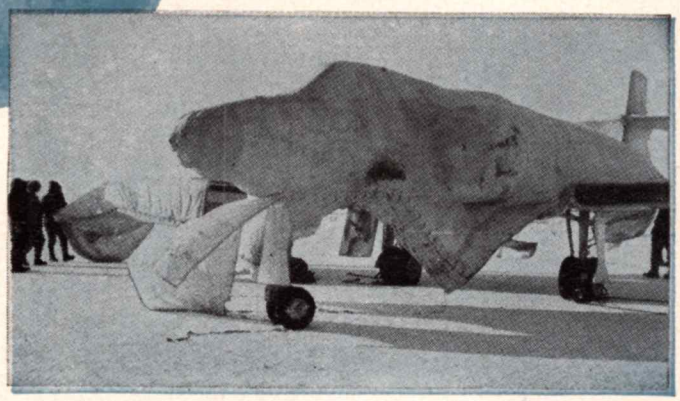
The other is known as the "reference channel" signal. This 9960 cps signal is frequency modulated at a 30 cps rate to 480 cps above and below 9960 (9960 cps is so close to 10 kc that references will be made to the "10 kc channel"). After this signal passes through a filter, limiter, and discriminator, the 30 cps voltage is known as the "reference" 30 cps voltage. Its phase is independent of the bearing from the transmitter.

Omnidirectional range transmission is such that at a receiving antenna bearing of zero deg. from magnetic north, the 30 cps "variable" modulation is in phase with the 30 cps frequency modulation of the 10 kc. At other points around the transmitter the two 30

Receiver-converter ensemble



for use... at 60° below



This CF-100 has had overnight "Cold Soak".

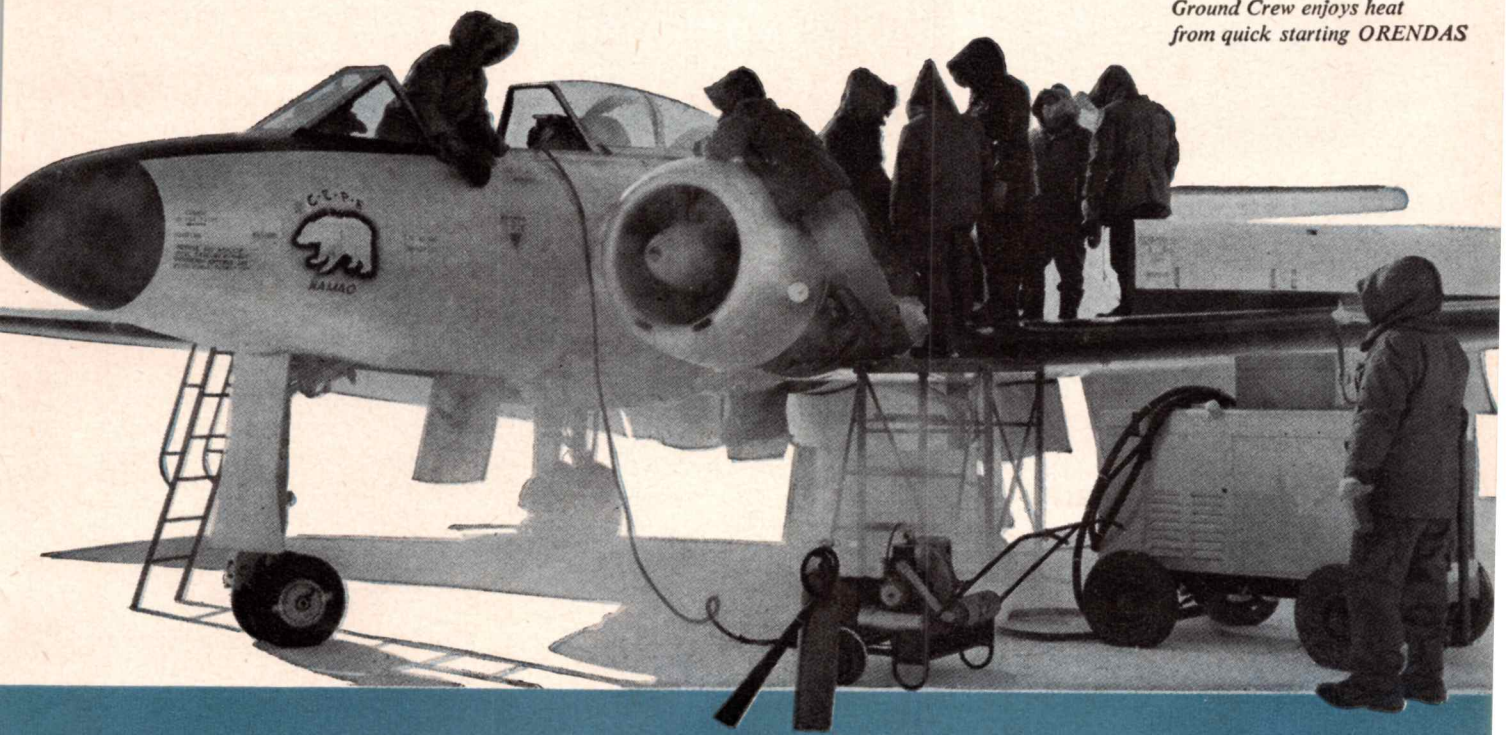
The CF-100 with its ORENDA's was meant to fly and fight in the Arctic. So that's where it's been tested. In the bitter wind-searing cold, engines must start, controls move, radio be clear, guns fire, and the pilot's hands and feet be comfortable within minutes after a "Barren Land" alert.

It's routine now to leave a CF-100 out overnight with but a light wrap to keep the wings clear of frost. After a 15-hour "cold soak" in temperatures of 30° to 60° below they pull the wraps, flick switches and take off. If it's not cold enough at Namao, near Edmonton, they fly non-stop to Fort Churchill on Hudson's Bay.

Defender of the Arctic, the CF-100 is in squadron service with the R.C.A.F. at strategic bases. On daily flights, it probes the perimeter of those areas most likely to need watching.

CF-100, WORLD FLIGHT RECORD—*the 2100 miles from Vancouver to North Bay was recently flown non-stop by a CF-100 in 3 hours, 50 minutes at 550 M.P.H. Piloted by F/L M. Kobierski with F/L D. Turner, Navigator, this was one of many tests performed by the CF-100's of 445 All Weather Squadron, R.C.A.F., Uplands, Ontario. It is the longest non-stop flight completed by a fighter aircraft.*

Ground Crew enjoys heat from quick starting ORENDAS



AIRCRAFT DIVISION

A.V. ROE CANADA LIMITED

MALTON, ONTARIO

AVRO CANADA

MEMBER OF THE HAWKER SIDDELEY GROUP

cps voltages differ in phase by an amount up to 360 deg. With the aid of the cockpit instruments, the function of the converter is to measure this phase difference which is then displayed on the course selector as a bearing from the transmitting antenna. This will be the relative bearing from station to aircraft.

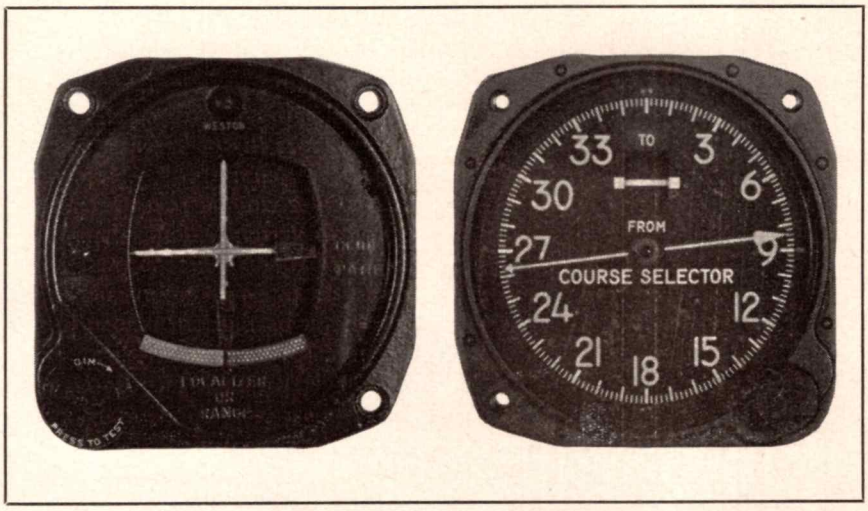
The function of the B-13 converter in receiving 90-150 cps localizer or visual-aural range signals is to take the complex audio frequency signal voltage from the cathode of the first af stage in the receiver and to convert it into direct current for operation of the vertical cross-pointer meter. The unit is a two-stage resistance-coupled af amplifier whose output is fed to 90 cps and 150 cps filters in parallel. Output from these filters is fed to rectifier circuits arranged to produce zero dc in the cross-pointer meter when equal 90 and 150 cps signals are fed into the filters. The input voltage to the filters is sufficient to produce the required off-course sensitivity of the cross-pointer meter.

The C-22A control unit is used for remote control of the equipment. It contains the on-off power switch, volume control, and a two-position switch for selecting reception of localizer (LOC) or VOR signals. In addition to the control unit, a cross-pointer meter with flag alarms, and a course selector with a built-in to-from meter are required in the cockpit.

The A-13B vhf navigational antenna provides an omni-directional antenna for connection to the 15D equipment, and a second antenna for connection to a glide slope receiver. Both antennas terminate in "baby N" coaxial receptacles, UG-291/U. The A-13B is suitable for use on aircraft from helicopters to multi-engine transports. It is a development from the military "ramshorn" antenna and mounting-wise is mechanically interchangeable with it.

Range Receiver

The R-11A range receiver is a navigation instrument specially designed for reception of the low-frequency radio ranges and for direction-finding or homing in the 190-550 kc band. The R-11A may be used with the ARC R-10A broadcast receiver and L-10A loop in lieu of a second ADF, or to back up a single ADF in case of failure.



Instrument face designs for localizer and course selector

The type R-11A receiver is a six-tube superheterodyne, continuously tunable over the frequency range of 190-550 kc. The receiver uses a three-section gang condenser to tune the rf oscillator and two rf tuned circuits. There are six tuned circuits in the if, at 85 kc. Automatic volume control is provided to make certain that receiver overload cannot occur. The audio level at which the AVC takes control is so high that the operator is forced to reduce sensitivity manually so that the signal output is at a comfortable level and safely out of the range of automatic control. This is essential for proper operation on the radio ranges.

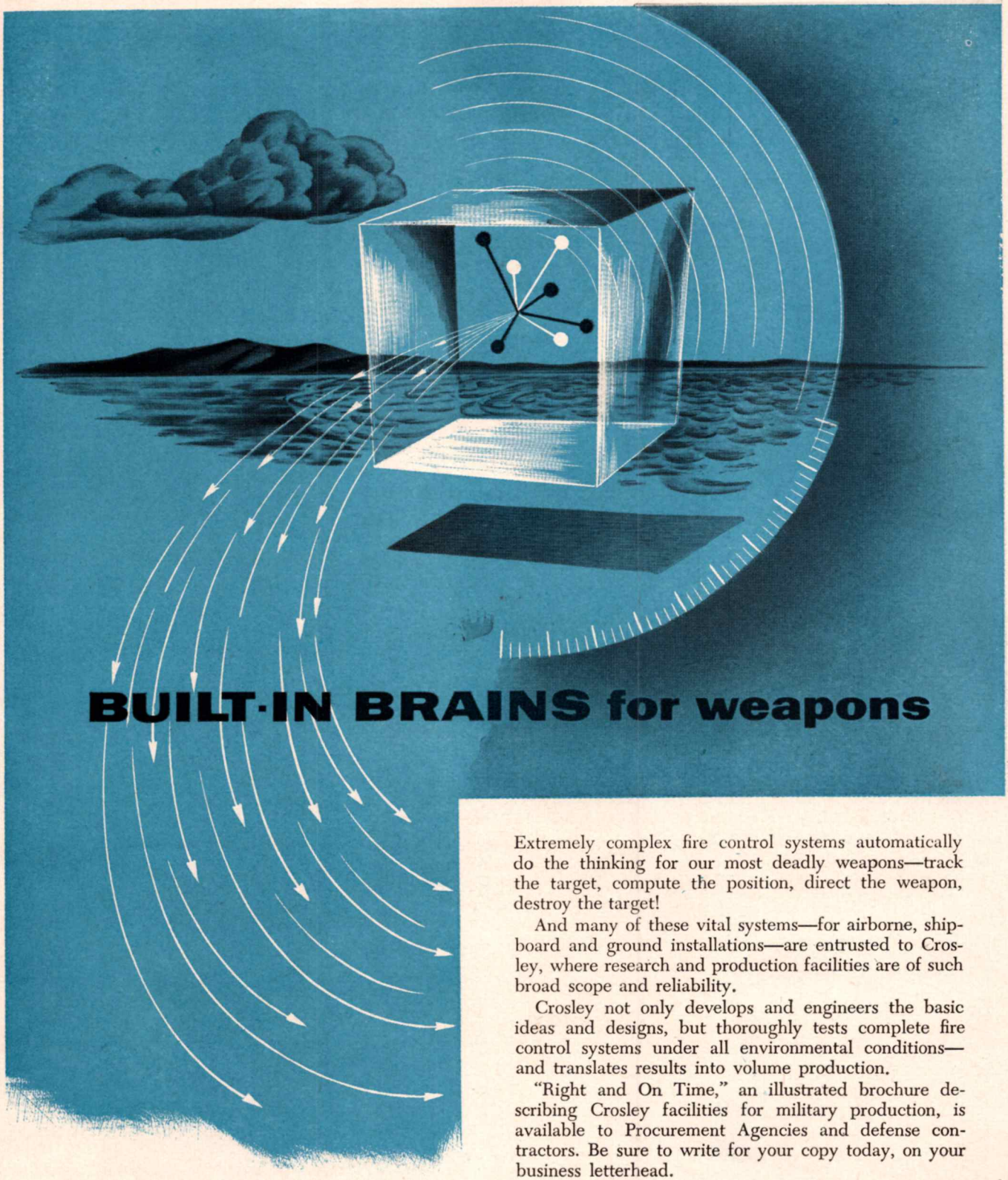
The AVC circuit has two diodes, one to produce the bias voltage and one to delay its action until the audio level is sufficiently high. A third diode is part of a noise-limiter circuit. The result of this noise-limiter action is that operation of the receiver is possible with a considerably higher static level than would otherwise be possible. A noise level in tuning between stations will be noted, which is also a result of this circuitry.

High selectivity coupled with high dial-calibration accuracy make it possible to use the dial calibration and known station frequency for tuning to desired stations. Ceramic insulation is used throughout the rf and if circuits. This feature, coupled with special treatment of coils, and the use of sealed chokes and transformers provide long-term protection of the equipment against the effects of high humidity and wide ranges of temperature.

The R-11A receiver is designed for operation from a short, fixed-wire antenna twelve to eighteen feet in length, although reasonably satisfactory operation may be achieved with antennas as short as six to eight ft. Optional operation is obtainable by use of the L-10A loop. Circuitry for direction finding is exceedingly simple, thus contributing to ease of maintenance with minimum equipment and personnel training. The R-11A is identical externally to the ARC Type R-10A broadcast receiver and makes use of similar M-12A mounting, D-10A dynamotor, and all connectors. These two receivers may be operated simultaneously on the same antenna or alternately on the same L-10A loop. Separate control units are utilized for operating the receiver and the loop.

Direction Finding

The L-10A loop is a nine-in. rotatable unit designed for top or bottom mounting on the aircraft. Loop operation is by remote control from the cockpit. The loop may be located as much as twenty feet from the cockpit, if necessary. To insure minimum rf noise, the



BUILT-IN BRAINS for weapons

Extremely complex fire control systems automatically do the thinking for our most deadly weapons—track the target, compute the position, direct the weapon, destroy the target!

And many of these vital systems—for airborne, shipboard and ground installations—are entrusted to Crosley, where research and production facilities are of such broad scope and reliability.

Crosley not only develops and engineers the basic ideas and designs, but thoroughly tests complete fire control systems under all environmental conditions—and translates results into volume production.

"Right and On Time," an illustrated brochure describing Crosley facilities for military production, is available to Procurement Agencies and defense contractors. Be sure to write for your copy today, on your business letterhead.

CROSLEY GOVERNMENT PRODUCTS DIVISION AVCO MANUFACTURING CORPORATION

CINCINNATI 15, OHIO

ENGINEERS: Constant expansion of long-range research and development contracts in electronics, electro-mechanical devices and fire control systems increases opportunities for highly skilled engineers. Contact our Director of Engineering.

connection from the loop to the small co-ax lead for the receiver is taken from a multiple-point contact against a gold-plated gear. The L-10A is satisfactory for operation up to speeds of 300 mph. Aural-null bearings on standard lf range stations up to 100 miles are sharp and well defined. The loop may be used in lieu of the wire antenna under certain conditions of heavy static.

Broadcast Receiver

The R-10A receiver is a navigation instrument specially designed for direction-finding or homing on signals in the 520-1500 kc standard broadcast band. The receiver is identical externally to the ARC R-11A range receiver, and makes use of similar M-12A mounting, D-10A dynamotor, receiver and loop control units, and all connectors.

The R-10A receiver is a six-tube superheterodyne continuously tunable over the frequency range of 520-1500 kc. Aside from the fact that if frequency of the R-10A is 239 kc, design features explained with regard to the R-11A receiver in the foregoing apply also to the R-10A.

VHF Transmitter

The Type T-11B VHF transmitter provides five crystal controlled frequencies in any two-megacycle band from 116 to 132 mc. An M-11A mounting serves to shock-mount and to attach each transmitter to structure. High-voltage power for the transmitter is obtained normally from the VHF receiver associated with the Type R-15 receiver or Type 15D omni receiving equipment, but may also be obtained from a separate R-11A LF range receiver, or from an R-10A broadcast receiver. One transmitter is usually designated Emergency and is powered from a second VHF or LF receiver.

The T-11B transmitter circuit comprises a Pierce oscillator and doubler out of the first tube, a second tripler, and an output doubler. Plate screen amplitude modulation is applied to the output power-amplifier. Power output is two watts or more with a dependable distance range of 60 mi at 5,000 ft. and 100 m. at 10,000 ft. The transmitter modulating circuits are used to provide a strong interphone. Silicone-treated ceramic insulation is used to increase reliability under extremes of moisture and temperature.

VHF Receiver

Many pilots require two VHF receivers, one of which is part of the Type 15D navigational equipment, and a second receiver for communication purposes. The ARC Type R-15 VHF receiver may be installed as a second VHF receiver. The R-15 is tunable over the entire VHF frequency band of 108-135 mc now assigned to civil flying. This will include voice transmissions made simultaneously with omnirange and other navigational signals.

Isolation Amplifier

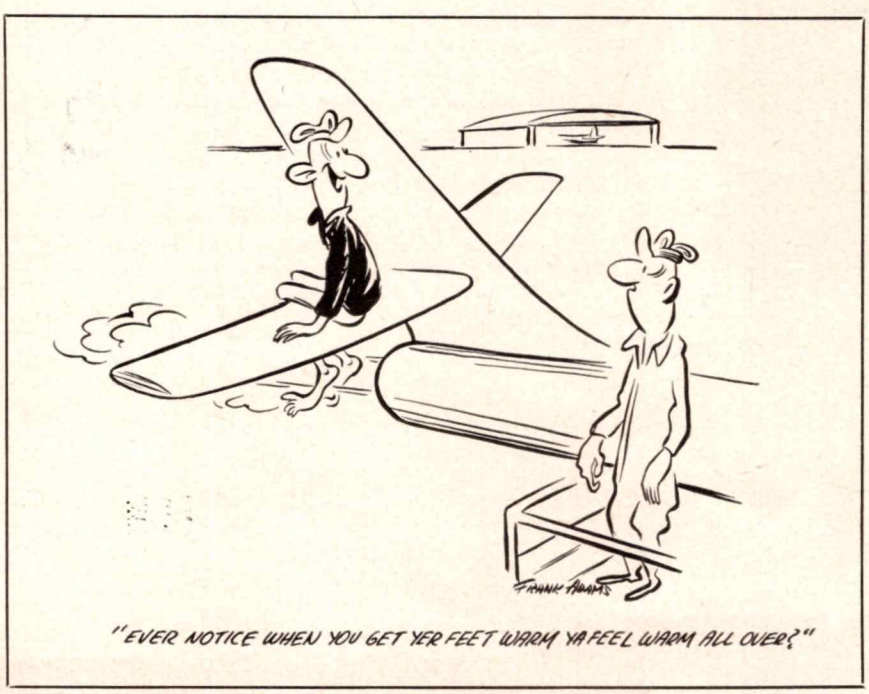
For two-pilot aircraft the addition of an ARC Type F-11A isolation amplifier is almost imperative if satisfactory division of tasks and responsibilities is to be achieved in the cockpit. The F-11A accepts up to 10 audio input channels from range and communication receivers, ADF's, marker beacon receivers, transmitter side-tones, and inter phones, as required. Each pilot may select any combination of channels without cross-cockpit interference. If more signals or more than two pilots are involved, two F-11A amplifiers may be installed.

Cockpit communication and radio navigation techniques have been evolved during the past few years in which pilot and co-pilot divide the work load, with the result that some signals are not required by both pilots. Under these conditions it is possible to connect as many as eighteen signals into the F-11A in such a way that eight special signals are routed to the pilot only, and eight to the co-pilot only, and two are common to both.

Marker-Beacon

The ARC Type R-20 marker beacon receiver is a four-tube amplitude-modulation type receiver designed for one-light visual-plus-aural 75 mc marker beacon operation.

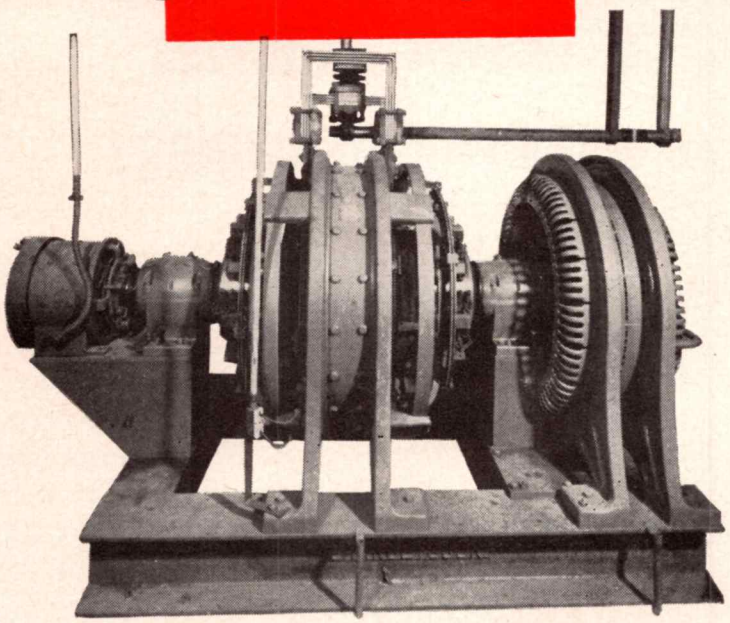
There are six R-F tuned circuits designed for mechanical and electrical stability under extremes of temperature, humidity, and vibration. The audio output of the receiver is controlled by a potentiometer and may be fed to the telephone circuit of the aircraft. Visual indication is provided by an indicator light which is energized by a relay on the R-20 upon reception of a signal at 75 mc. modulated at 400, 1300, or 3000 cycles. An "expansion" circuit in the receiver effectively narrows the cone of reception over a marker—gives a sharp definition to the edges and "squelches", that is to say, silences the receiver output when not over a marker. END



CUT POWER COSTS PERMANENTLY...

Chandeysson MOTOR GENERATORS

for high-efficiency anodizing & plating



GOLDEN 1904 Chandeysson 1954 JUBILEE

Showing Chandeysson Generator that has served Miller Electroplating, Inc. for many years.

4 WAYS BETTER...

1. You'll use *less* power
2. Get more out of the power you pay for
3. Get extra overload capacity for long periods
4. Profit indefinitely — from peak performance built to last for years

Lifetime savings and satisfaction...

"CHANDEYSSON CUTS POWER CONVERSION COSTS"

...says Miller Electroplating, Inc. of Evansville, Indiana

"... We have three of your machines in operation in our plant. The last two being purchased after using the first one for over 20 years.

"Our first machine has been in use on the average of 16 hours a day. A great deal of this time, carrying an overload of from 20 to 25% of its rated capacity. During this time the only maintenance expense has been new brushes. It might be of interest for you to know that the commutator has not even been repaired during this time.

"We are indeed thoroughly sold on Chandeysson Plating Generators.

Very truly yours,
MILLER ELECTROPLATING, INC.

Paul E. Miller, Pres."

Cost-cutting performance is permanent in Chandeysson Motor Generators... built-in for the life of the unit. That life can be almost indefinite, as witness the Miller experience described here, and that of others whose Chandeysson installations are still in constant use after 48 years of service!

You get *immediate* savings, too. These units are capable of improving your overall plant power factor with resultant reduction of shop current for the same KW load all along the line!

Chandeysson Motor Generators are lastingly dependable, capable of carrying overloads for long periods — yet, they cost less than other methods of power conversion. We invite you to investigate. The coupon — or your letterhead — will bring you complete information.

CHANDEYSSON ELECTRIC COMPANY
4080 Bingham Avenue, St. Louis 16, Missouri

CHANDEYSSON ELECTRIC COMPANY
4080 Bingham Avenue, St. Louis 16, Missouri

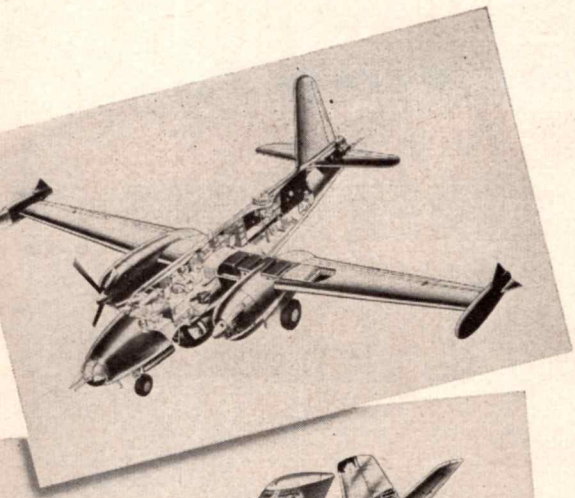
Please send me a copy of Bulletin D-102.

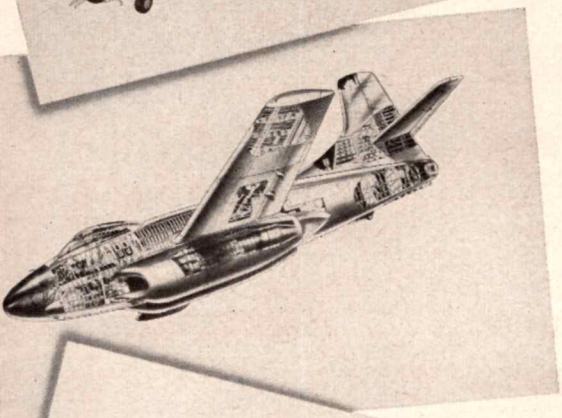
Name.....

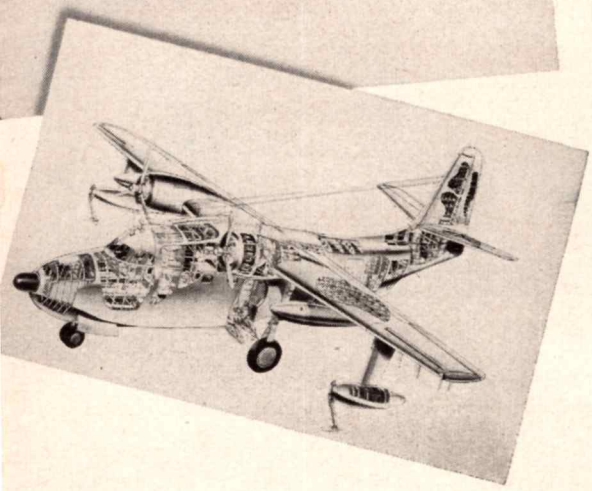
Company.....

Address.....

City.....Zone.....State.....







YOURS FREE...

when you subscribe to Aero Digest for one year at $3.!

6 DESIGN ANALYSIS CUTAWAY DRAWINGS!

These are the same cutaways of famous planes that are prepared exclusively for, and appear exclusively in, AERO DIGEST each month. They are the same cutaways that have established themselves as the most popular feature we've ever published, and have been accepted as *the* standard in aviation. Now you can have any six of the drawings listed here . . . each of them full 16" x 20", each of them a useful and attractive addition for your office walls or reference files.

But don't delay; this offer is limited. Select the 6 design analysis drawings you want from the complete list below. Then fill in the coupon, and mail it to us right now, so that we can send you your drawings at once, and start your subscription with the current issue of AERO DIGEST.

NOTE TO PRESENT SUBSCRIBERS:

You may take advantage of this special offer and get your free design analysis drawings by using the coupon to renew your present subscription in advance. Thus, when your present subscription expires, you will be entitled to another full year of AERO DIGEST, PLUS the six free cutaway drawings, which we'll send you right now. Please be sure to indicate on the coupon whether you're ordering a new subscription, or a renewal.

CHOOSE ANY 6 OF THESE FAMOUS PLANES!

☐ Bell	X-5	
☐ Chance Vought	F4U-5	Corsair
☐ Convair	340 Liner	
☐ Douglas	F3D-2	Skynight
☐ Fairchild	C119-H	Skyvan
☐ General Electric	J-47 Turbojet	
☐ Grumman	SA-16	Albatross
☐ Lockheed	P2V-6	Neptune
☐ Martin	P5M-1	Marlin
☐ McDonnell	F2H-3	Banshee
☐ North American	F86-A	Sabre
☐ Piasecki	H21-C	Workhorse
☐ Republic	F84-F	Thunderjet
☐ Sikorsky	S-55	
☐ Wright Flier	1903	

Each of these drawings measures full 16" x 20"—approximately 4 times the size of this page—printed on heavy paper, suitable for framing.

FILL IN AND MAIL THIS COUPON RIGHT NOW!

AERO DIGEST
515 Madison Avenue
New York 22, N. Y.

Please send me by return mail the 6 design analysis cutaway drawings checked at left, and enter my subscription for 12 big issues of AERO DIGEST at $3.

——Remittance enclosed. ——You may bill me later.

——This is a NEW subscription. ——I am a current subscriber; please RENEW my subscription at its expiration.

NAME _____

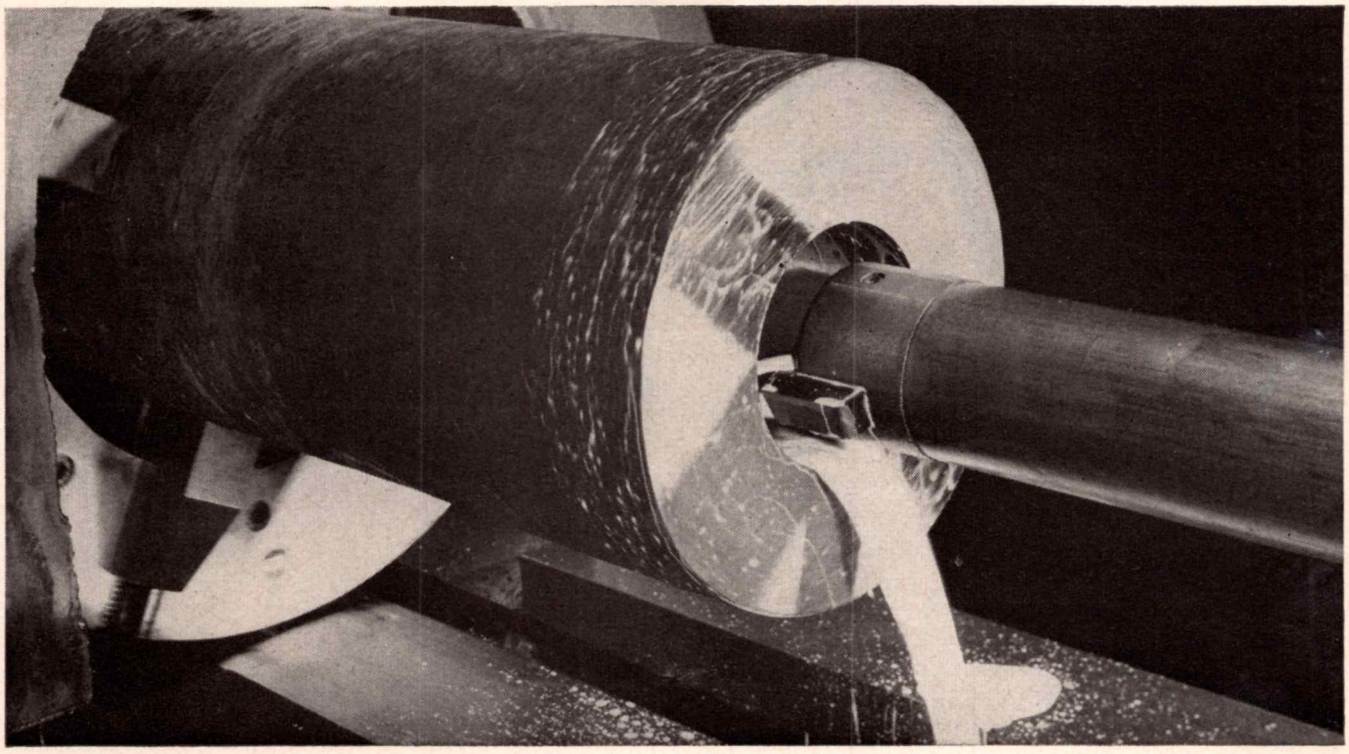
ADDRESS _____

CITY _____ ZONE ____ STATE _____

COMPANY _____ POSITION _____

Cutaways Will Be Sent Promptly Upon Receipt of Remittance

START WITH FINISH BORING!



TIMKEN® seamless steel tubing saves steel, machining time!

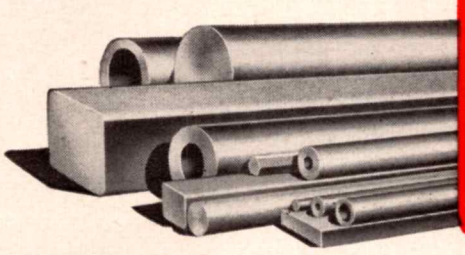
FINISH boring is your first production step when you use Timken® seamless steel tubing instead of bar stock for your hollow parts jobs. You don't have to bore out the center hole. With Timken seamless tubing, it's "built-in"! So screw machine stations are available for other jobs. You add machining capacity without adding machines.

Because the center hole is already there, you also save steel with Timken seamless tubing. There's far less metal to machine away, giving you more parts per ton of steel.

To save you even *more* steel, the Timken Company's engineers will study your problem and recommend the most economical tube size for your hollow parts job—a size guaranteed to clean up to your dimensions.

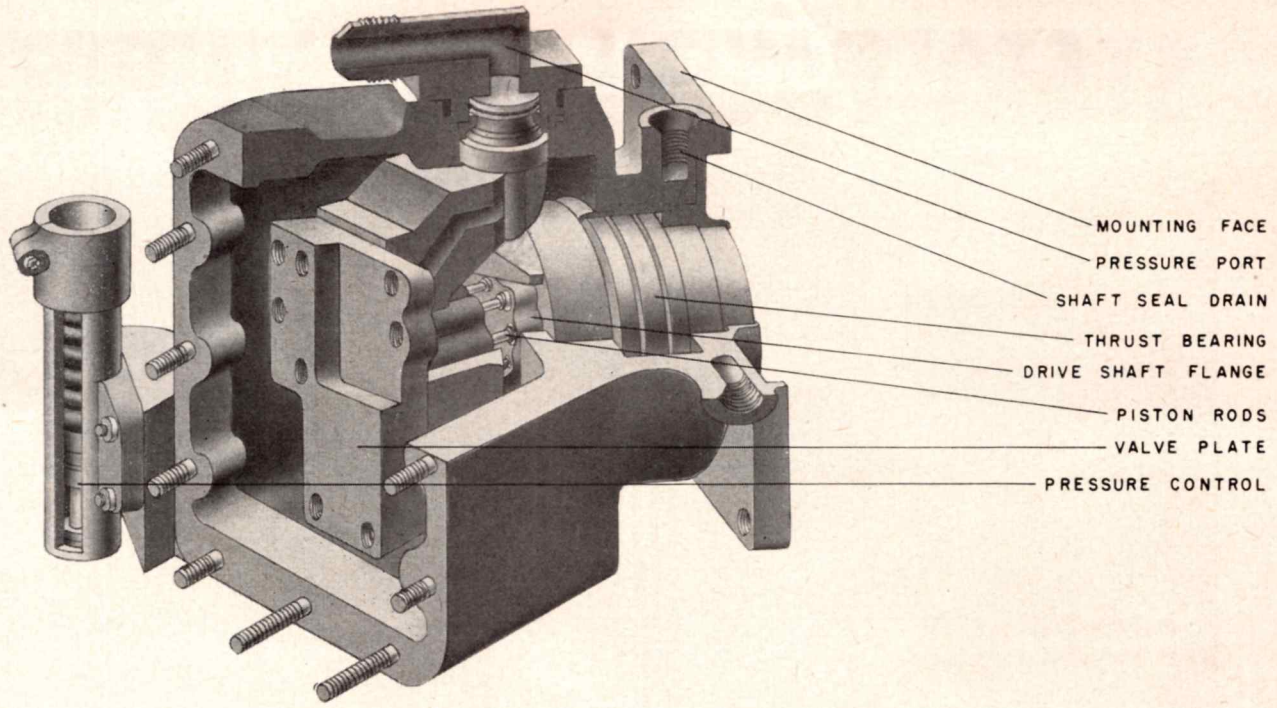
Timken seamless tubing results in a better quality product, too. The piercing operation by which Timken tubing is made is basically a forging operation. This gives the tubing a uniform spiral grain flow and a refined grain structure that brings out the best in the quality of the metal. And this quality is uniform from tube to tube and heat to heat, due to the Timken Company's rigid quality control. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



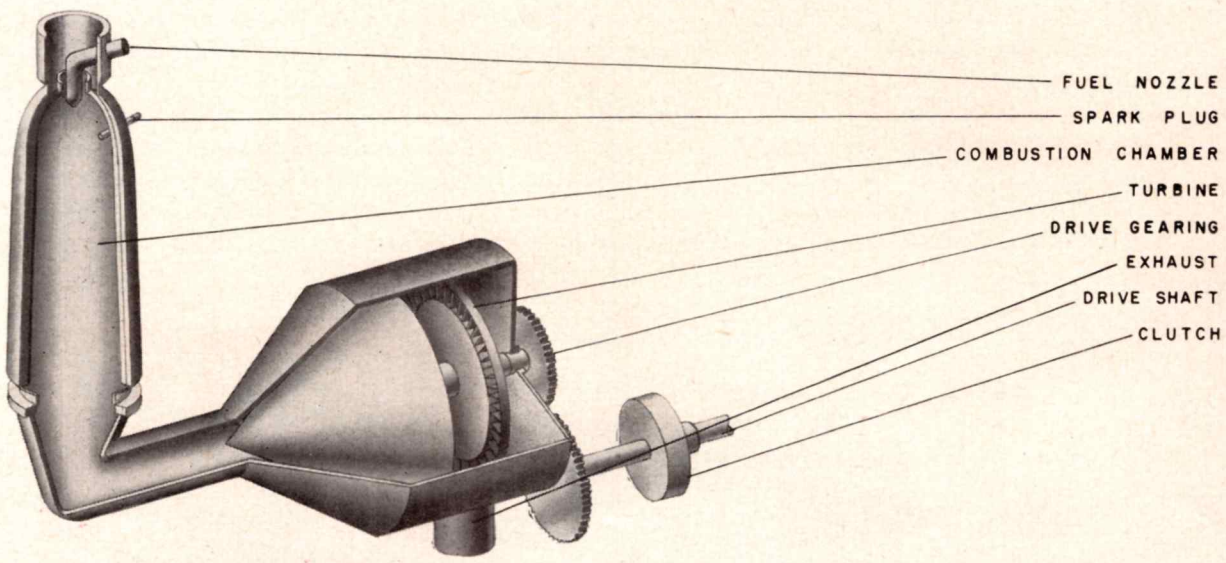
TIMKEN
Fine Alloy
STEEL

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

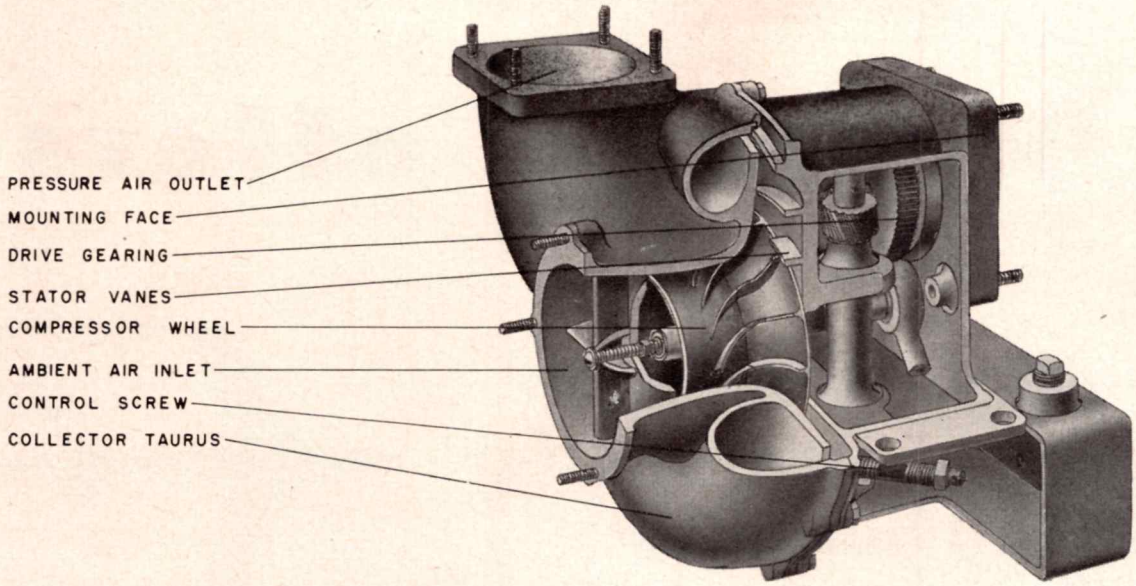


VARIABLE DISPLACEMENT HYDRAULIC PUMP

COMBUSTION TURBINE STARTER



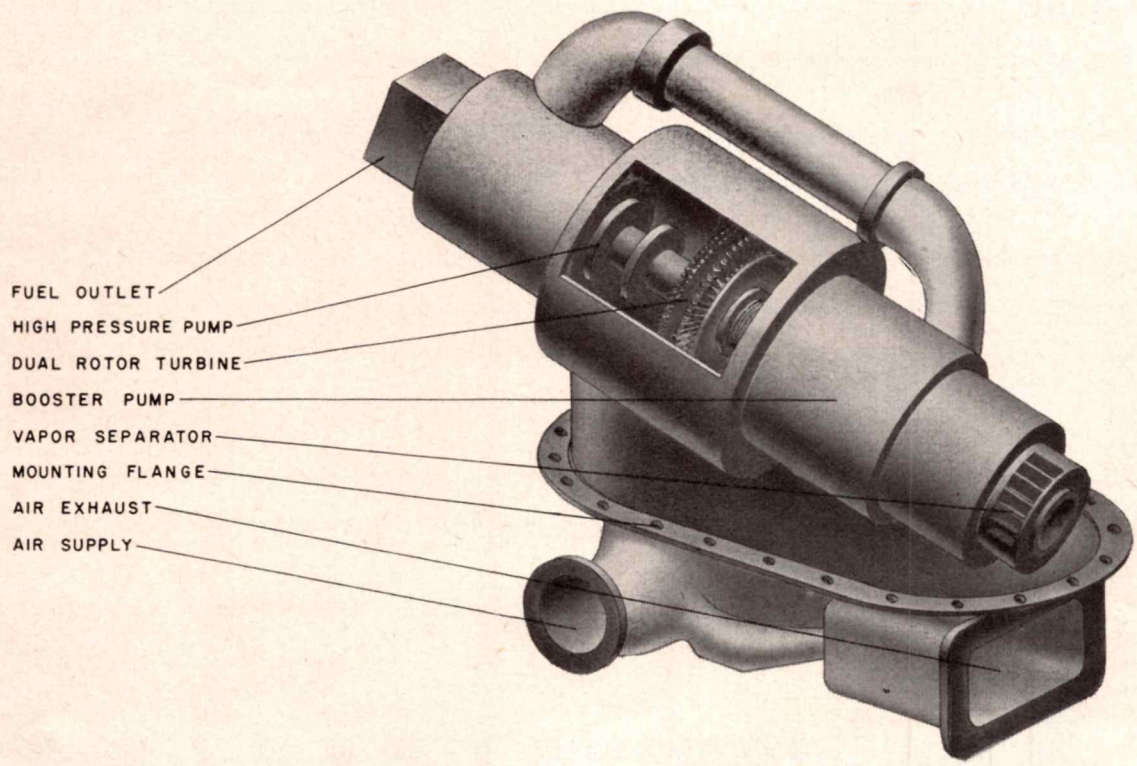
AIRBORNE ACCESSORIES.



CABIN AIR SUPERCHARGER

AERO DIGEST CUTAWAY

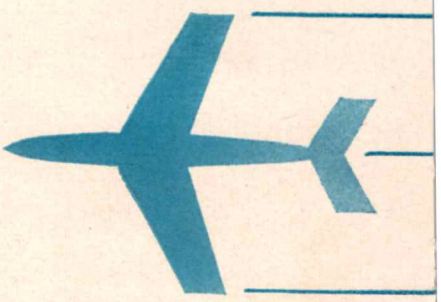
AFTERBURNER FUEL PUMP



THESE UNITS TYPIFY THE COMPLEXITY OF NEW AIRCRAFT EQUIPMENT

Saginaw offers

and multiple circuits in ball bearing screws offer multiple advantages

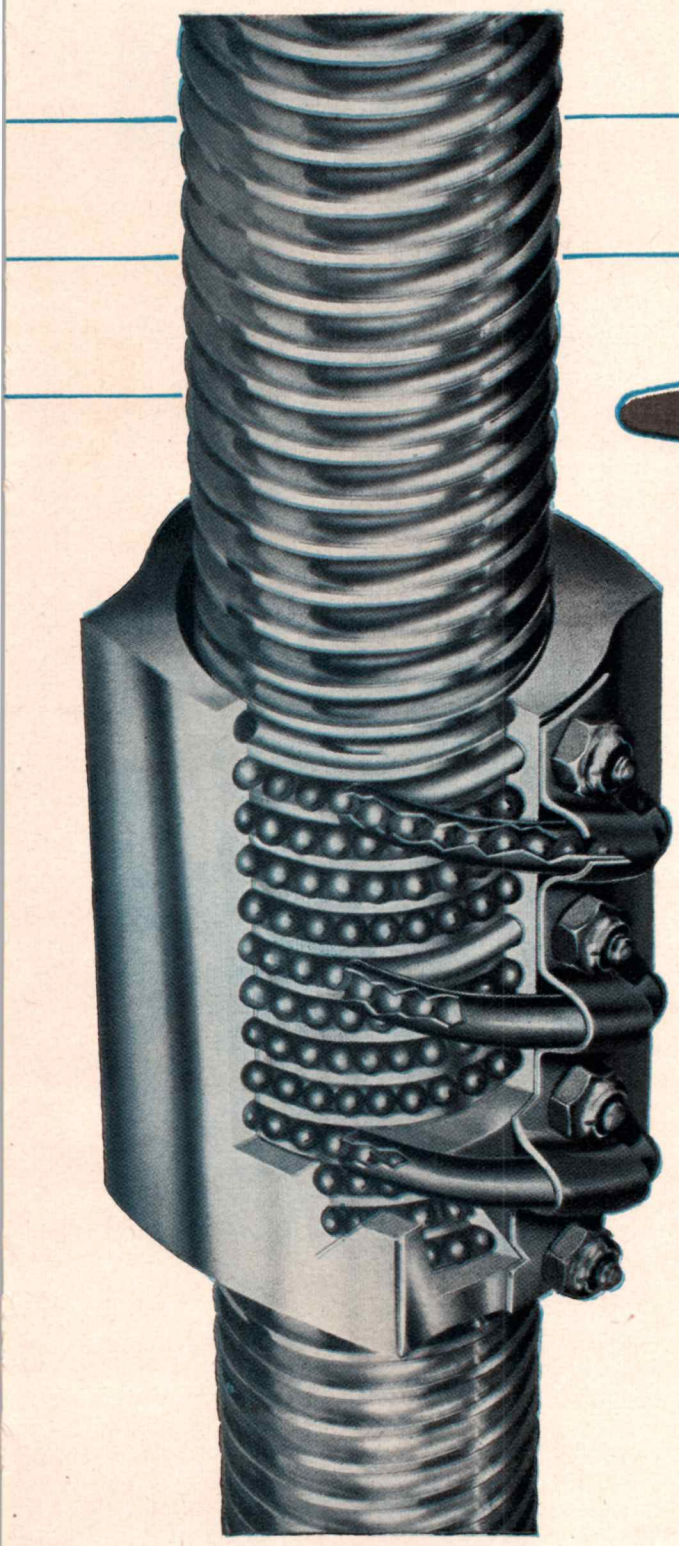


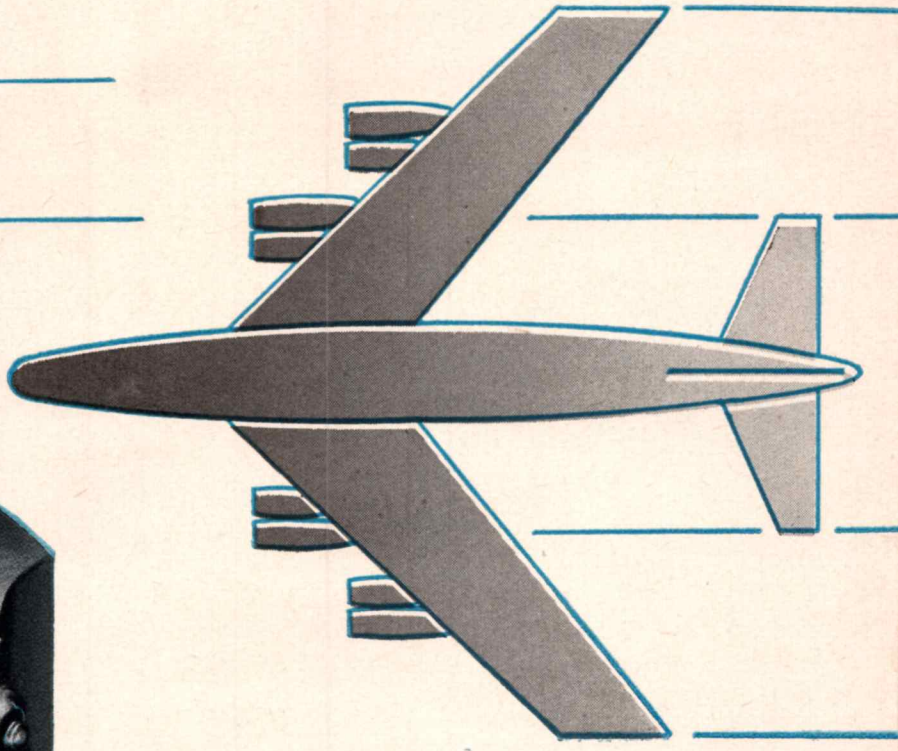
- **less weight** In a Saginaw Ball Bearing Screw every ball carries its share of the load. No balls "go along for the ride", simply as spacers. Thus, far fewer balls are required and therefore a substantially shorter, smaller and lighter nut is necessary to contain the balls for a given load.
- **greater capacity** Conversely, a nut of a given length is capable of carrying a substantially greater load than those of other designs. Thus, either way, a Saginaw Screw is advantageous.
- **increased efficiency** Because with multiple circuits, no more than 3½ turns for each circuit are required, the balls operate with greater fluidity — and maximum efficiency.
- **insured safety** In the rare event of a ball-failure, in a multiple-circuit Saginaw Screw, only one circuit is inactivated, and the other circuits "carry on".
- **experience for you** The Saginaw Steering Gear Division pioneered in the development of the recirculating ball-nut screw. The continuous research and development of the engineering staff is available to help you increase the dependability and efficiency of the actuators in your product, and to cooperate with you on any new applications you may have.

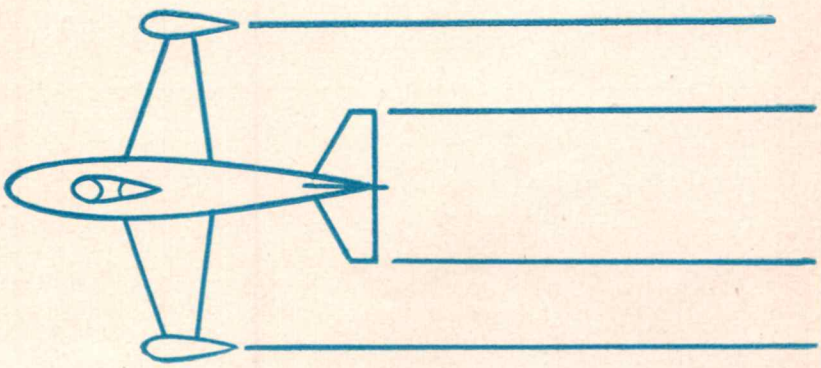
Saginaw Screws can be supplied in 1, 2, or 3 circuits and in a complete range of load and life requirements for use with electrical, hydraulic or pneumatic units. Write today for our free engineering data book.

Saginaw STEERING

multiple circuits...

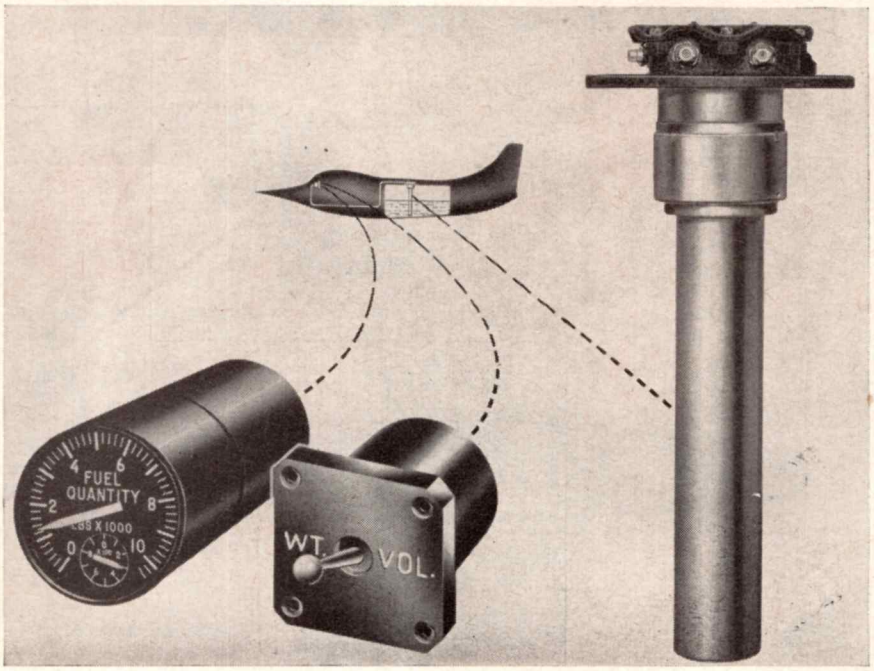






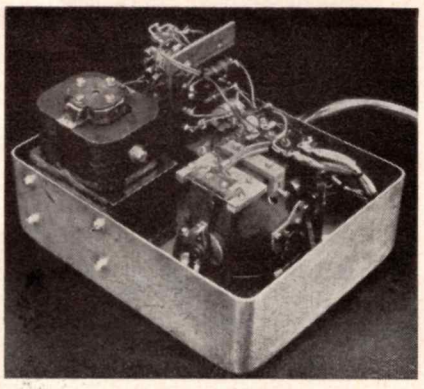
GEAR DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN
MANUFACTURERS OF SAFETY POWER STEERING



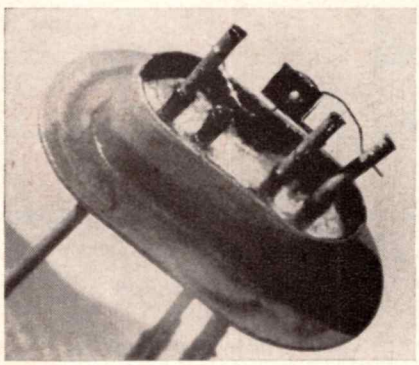
Capacitor Fuel Gage

Latest Liquidometer Corp. capacitor type fuel gage contains a new circuitry permitting two-tube construction, instead of the three tubes previously used. The indicator section of the indicator amplifier is hermetically sealed in an atmosphere of inert gas, while the rear portion is housed in an easily removable dust proof cover permitting replacement of vacuum tubes. The three miniature bayonet type shielded connectors mounted on the back of the combination unit are only ½ to ¼ previous size and ⅔ to 4/5 lighter in weight. They are self-sealing, have practically no internal air space and improved insulation qualities. System shown in illustration offers a dual indication of fuel remaining: gravimetric or volumetric. This system consists of a standard capacitor type gage and a small panel mounted selector switch. A full tank condition can be determined during refueling operations by switching to the gravimetric reading. The double dial calibrations permit reading either volume or weight of fuel remaining by a flick of the switch.



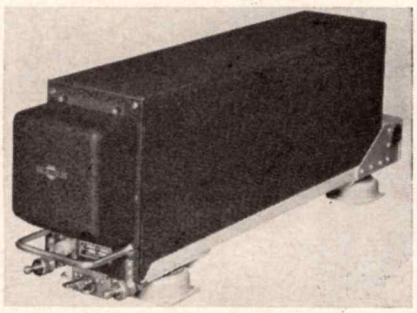
Rate Integrating Detector

A new rate integrating detector that can replace the more complex mating of rate and directional gyros in automatic control systems has been developed by Summers Gyroscope Co. The unit, Model 97, is tumble-free and uses no vacuum tubes nor magnetic amplifiers. It operates through the transfer of rate gyro signals to the integrating motor. The motor, in turn, integrates the signals in such a way as to post the aircraft autopilot on angles of variation in position and space. A direct electrical signal will change the reference angle, thus dispensing with the conventional torquing motor used with the rate and directional gyro combination. The complete detector unit is made up of a Model 70 Rate Gyro and a Model 120 Integrating Motor mounted within a 4.75 in. x 5.75 in. x 4.5 in. case weighing only three lb. The unit is hermetically sealed and contains a corrosion-resisting inert gas.



UHF Transistor

Bell Telephone Laboratories, where the original transistor was invented, has developed a new "intrinsic barrier" transistor which can generate frequencies as high as 440 million cycles per second, about four times that of any comparable transistor. The new junction transistor was developed by adding an intrinsically pure layer to the basic positive-negative-positive wafer, thereby providing a "shock absorber" action for high voltage electrical charges. This chemically-pure part of the germanium crystal remains neutral while three adjoining sections become positively or negatively charged. The "intrinsic barrier" isolates the input and output areas, permits faster movement of positive charges and reduces the stored energy to make functioning possible at higher frequencies. The new transistor can operate at less than one-hundredth the power needed by a vacuum tube yet can also withstand as much as 100 volts.



VHF Receiver

The Collins Radio 51X provides 360 channels of reception in the VHF frequency range of 118.0 to 135.9 mc with 50 kc spacing. The receiver has a 50-watt output and a signal-to-noise ratio for a 2 mv signal modulated 30 percent at 1000 cps of 6 db or better. The input circuit is unbalanced type with an impedence of 52 ohms. Power requirement is a dynamotor requiring 27.5 v d-c or a transformer/rectifier requiring 115 v at 300-1000 cps a-c and 27.5 v d-c. Unit weighs 31 lb. including shock mounts.

6

All six military transports now fly MORE SAFELY with

BENDIX-PACIFIC AIRBORNE RADAR

BOEING KC-97

FAIRCHILD C-119

DOUGLAS C-124

LOCKHEED C-121

DOUGLAS C-118

LOCKHEED C-130

AN/APS-42A
developed and produced by Bendix-Pacific

With this proven lightweight radar set, developed and being produced by Bendix-Pacific, all terrain is continuously indicated . . . and pilots can "see" storm fronts as well as other aircraft in the vicinity.

Progress in airborne radar is a vital factor at Bendix-Pacific. Newer, smaller and lighter airborne radar equipment has already been developed with continuous advancements under way.

Bendix-Pacific is specializing in airborne radar for both aircraft and missiles. It will pay you to discuss your requirements with us.

RADAR

SONAR

HYDRAULICS

TELEMETERING

ELECTRO-MECHANICAL

ULTRASONICS

BENDIX PACIFIC

THE NAME Bendix AVIATION CORPORATION MILLIONS TRUST

PACIFIC DIVISION • Bendix Aviation Corporation
11600 Sherman Way, North Hollywood, California

East Coast Office: 475 5th Ave., N.Y. 17
Export Division: Bendix International 205 E. 42nd St., N.Y. 17
Canadian Distributors: Aviation Electric, Ltd., Montreal 9

$5,000.00 IN AWARDS

SEND YOUR ENTRY NOW TO THE BIG MONTHLY

AERO DIGEST DESIGN FORUM CONTEST

Purpose of the forum is to give industry-wide recognition to the research, design, engineering and production achievements of today and to encourage and foster even more brilliant achievements in this industry's great future.

How you can qualify

Any citizen of the United States who is not a staff member or relative of a staff member of AERO DIGEST is eligible to submit an entry in the AERO DIGEST Design Forum.

Rules and suggestions

Entries will be judged on the degree to which they improve flight safety, reduce airplane complexity, or provide a manufacturing cost saving through engineering judgment and the application of technical skill.

Entries can vary from a simple bracket to a complete airplane, power plant or missile design; there are no limitations on the form or substance of the design.

All entries will be accepted without any restrictions. You do NOT have to be a subscriber to AERO DIGEST nor fill out a complicated official entry blank. It will enhance your entry's clarity and attractiveness if it is neatly drawn in perspective in India ink on double-weight white paper, but all entries will receive equal consideration regardless of degree of artistic effort.

AERO DIGEST requires of entries *first magazine publication rights only*. The magazine specifically renounces any and all other claims to design submitted. That a design has previously been published in a technical paper or a manual does not disqualify it. Previous publication in an aviation trade journal, however, does disqualitfy it. *All entrants retain in full any and all other patents, copyrights, or publication rights to their design.*

Each monthly forum competition closes on the first of the month preceding the month of issue and awards. For example, closing date on the awards to be announced in the December issue is November 1. All entries received after the monthly closing date will automatically be considered in judging entries the following month. *All entries, regardless of when received or of whether they win a monthly award, will qualify for the annual grand prizes if mailed on or before December 1, 1954.*

Every effort will be made to take care of all material submitted, but AERO DIGEST cannot be held responsible if material is lost. Receipt of your entry will be promptly acknowledged. To keep the staff work load to a minimum, we request that you ask for the return of your entry only if it has genuinely future value to you. Entries should be clearly marked if you want them returned.

Checks will go to monthly winners as far in advance of publication of the magazine as possible. Annual awards will be made at the time of publication of the February, 1955, issue of AERO DIGEST.

Judging will be done by a distinguished board of aeronautical engineers, the Consulting Editors and editorial staff of AERO DIGEST:

DR. MAX MUNK, Chairman of the Department of Aeronautical Engineering, Catholic University

R. J. SANDSTROM, Vice-President, Engineering, Bell Aircraft Corporation

A. A. VOLLMECKE, Chief, Airframe and Equipment Engineering Branch, Civil Aeronautics Administration

O. E. TIBBS, Chief Flight Test, The Glenn L. Martin Co.

The decision of the judges shall be final.

$5,000 in Awards

Monthly awards will be made at the time the winning designs appear in the August, September, October, November and December, 1954 editions of AERO DIGEST.

Monthly Awards:
First: $250.
Second: 125.
Third: 100.

Annual Awards:
First: $1000
Second: 750
Third: 500
Three honorable mentions, $125. each—$375.

Annual Awards will be made concurrent with the announcement to the winners in the February issue, 1955.

In case of ties, duplicate prizes will be awarded.

How to enter your design

Simply submit your design to The Editor, AERO DIGEST Design Forum, 511 11th Street, N.W., Washington 4, D.C. No entry blank is required, but your entry should be accompanied by a letter stating that the material in your presentation is your original work.

There are no limitations on the length of text used to describe the entry. However, it should contain the following data:

(a) Name of design
(Example: Throttle Ratchet Mechanism, Rotor Blade Attaching Means, etc.)

(b) Purpose of design
(Example: To keep throttle in preselected position and to permit motion to full idle cut-off position: To transmit blade loads to fuselage structure while simultaneously permitting flapping and lagging action and control of blade angle, etc.)

(c) Contest claim
(Example: Reduces complexity by avoiding necessity for long runs of cable; Improves flight safety by permitting pilot to lock unit completely out of system in emergency; and permitting attachment by rivets, rather than bolts, Reduces manufacturing cost by using cheaper raw stock etc.)

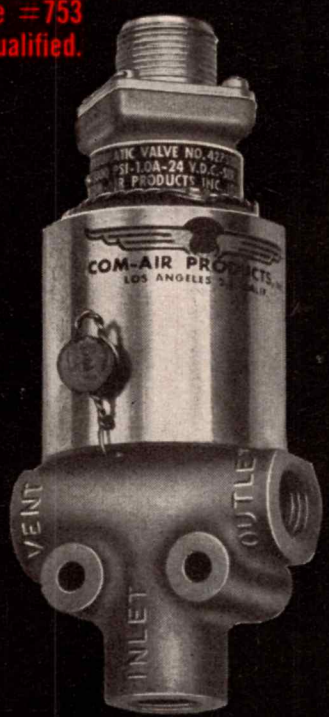
(d) Comment
Where designs involve operating mechanisms, a brief statement of its sequence of operation; where design is part of a system, a brief statement of its function within that system for clarity; or a brief comment on a particularly interesting history of a design in which a previous design proved faulty and why and the manner in which the new design cured the trouble. A statement as to the current use of the design in a specific aircraft and a report of its suitability is always of interest.

AERO DIGEST DESIGN FORUM

Send all entries to: • 511 11th St., N.W. Washington 4, D. C.

NO LEAKAGE VALVE*

Solenoid Operated Pneumatic Valve =753
*and Fully Qualified.



3 way 2 position normally closed
OPERATING PRESSURE 0 TO 3000 PSIG
current drain 1 amp. at 24 VDC max.
continuous duty
weight 1.1 lbs.
-65°F to 160°F ambient temperature
leakage 5 cubic inch per hour max.

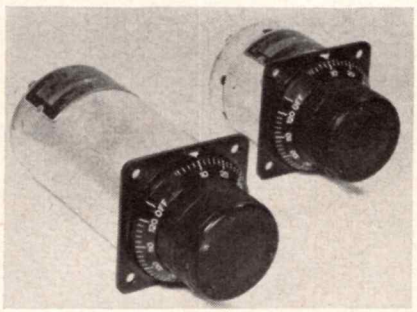
ENGINEERED AND MANUFACTURED BY

com • air

PRODUCTS INC.

1201 Rio Vista • Los Angeles 23, California

DESIGNERS AND MANUFACTURERS OF HYDRAULIC AND PNEUMATIC AIRCRAFT EQUIPMENT



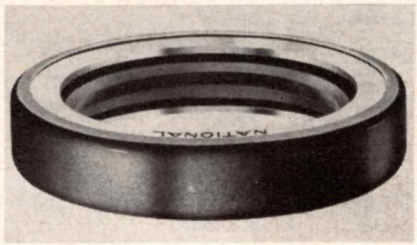
Intervalometers

Abrams Instrument Corp. has developed intervalometers for sequence timing in telemetering and various airborne control systems. The unit (left) furnishes a 28-v, 3-amp d-c inductive pulse of 0.25-sec. duration at regular time intervals, controlled by the dial. Repeat accuracy is within plus or minus 10 microseconds over a supply voltage range of 24 to 29 v d-c. The time interval scale on the dial provides four ranges (12, 24, 60 or 120 sec.) in 0.1, 0.2, 0.5 or one sec. increments.

An auxiliary instrument, the count limiter (right) may be used as a pulse counter and limiter for stopping at the desired number of pulses from one to 120. Two such units may be connected to provide control up to 14,400 pulses.

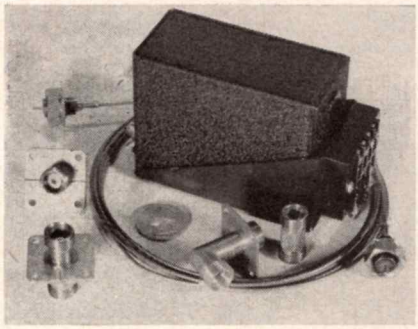
Vacuum Gauge

The Hastings Vacuum Gauge for instantaneous measurements of vacuums in the 1 to 1000 microns Hg range is being offered in a panel-mounted model for the first time by the Hastings Instrument Company of Warwick, Va. The panel-mounted instrument, which employs a patented principle of directly heated thermocouples, is designed for test panels in such applications as vacuum pumping, metal vacuum depositing or with other vacuum processing equipment in such fields as vacuum tube and refrigeration equipment manufacturing. The panel-mounted Hastings Vacuum Gauge has noble metal thermocouples and nickel-plated gauge tubes which afford freedom from outgassing, system contamination and corrosion. Calibration of gauge tubes is not affected by changes in ambient temperature or exposure to atmospheric pressure. Because the thermocouples in the sensing element are directly heated, they reach operating temperature within one half second for fast response, according to the manufacturer. The panel-mounted model is a direct reading instrument suitable for continuous reading or recording. The instrument is 7 in. high, 7.5 in. wide, 2.25 in. deep and weighs 3.5 lb.



Cementless Seal

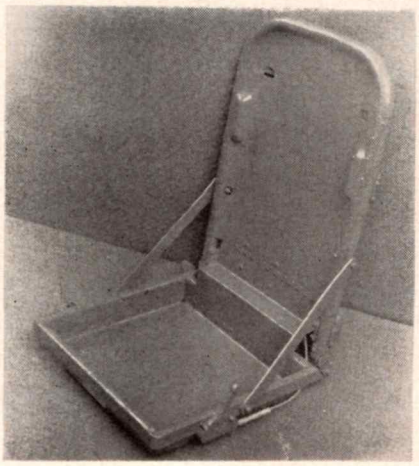
A process providing positive sealing between a housing bore and the outer case of a metal-encased oil seal without cementing has been announced by National Motor Bearing Co., Inc. The process consists of a coating material applied at the factories on the metal circumference of the oil seal. The coating serves as the sealer; no cement is required. The coating material, tested under all conditions over a three-year period, is hard to the touch, does not adhere to containers, other seals or pick up dirt, and is brightly colored for ready identification. As the oil seal is introduced into a press-fit bore, the coating completely fills radial or circumferential scratches or imperfections as deep as .003 in. Once in place, the sealing is permanent and is unaffected by temperatures ranging from –60 deg. to 350 deg. F. Seals may be removed easily even after prolonged operation at high temperature.



Fire Detection System

Now flying on several commercial and military planes including the Convair F-102 jet fighter, the new Edison type B fire detection system is light, simple, and false-alarm proof. A continuous sensing element used is temperature-sensitive at any point along its length. Since the cable has no "blind spots," when installed with respect to air flow and other pertinent factors, fire cannot escape undetected.

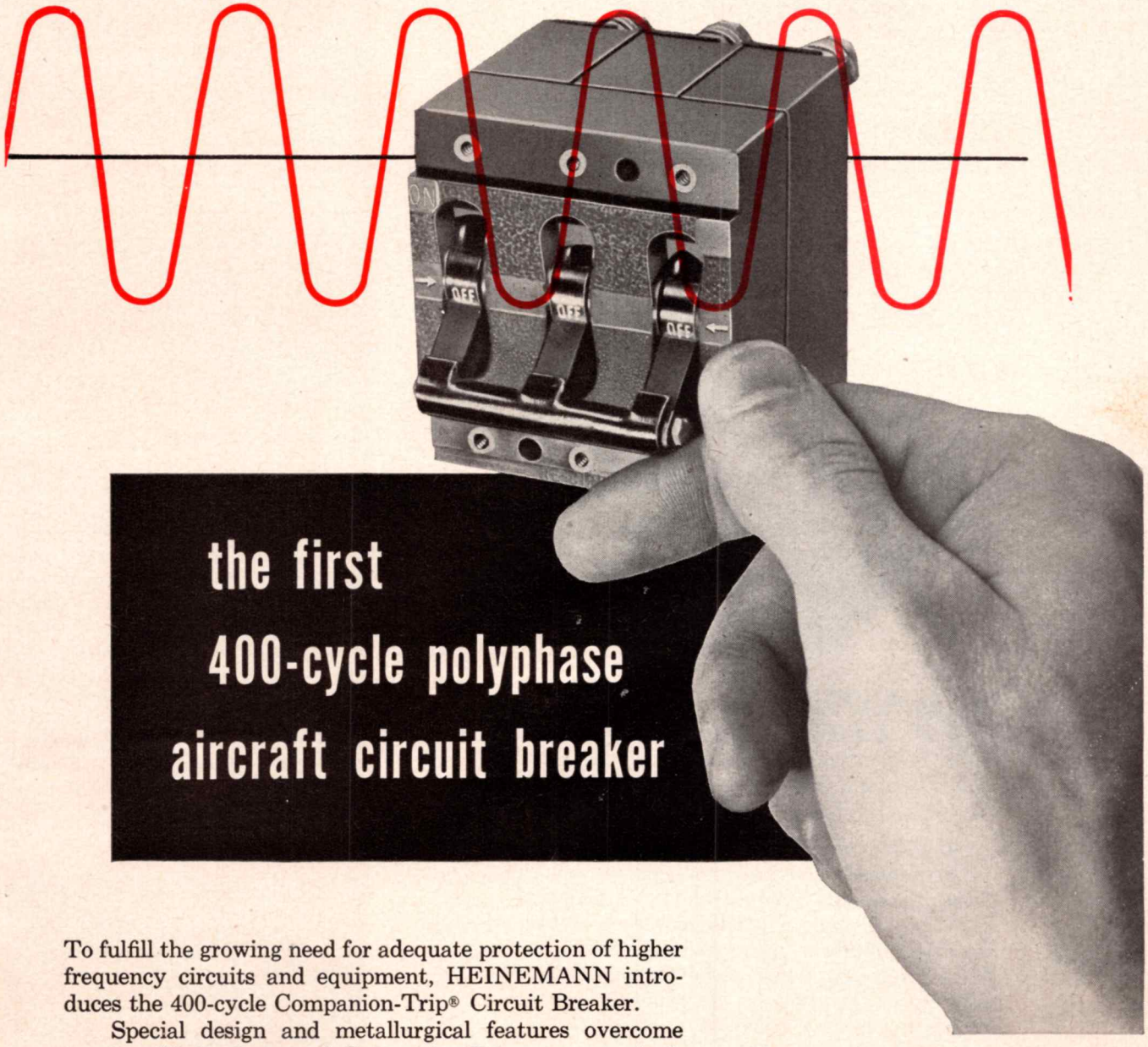
The system uses an electrical circuit of low impedance—short circuits external to the system are not induced by humidity or capacitive effects. The flexible fire-sensitive cable, 0.070 in. in diameter, available in standard lengths up to 20 ft. is strung throughout the areas to be protected. This coaxial cable contains a single wire, separated from the outer sheath by a thermistor-like semi-conductive material in which electrical resistance drops sharply when temperature rises. At a given flame-heat temperature, the thermistor material permits a small amount of current to flow from the inner wire to the sheath, directly activating a relay which switches on the alarm.



Short Range Pilot Seat

Aerotherm Corp. has developed a new pilot seat to be used in Beech's T-34B Navy trainer. The Model 483 short range seat can also be used on

ANNOUNCING...



the first 400-cycle polyphase aircraft circuit breaker

To fulfill the growing need for adequate protection of higher frequency circuits and equipment, HEINEMANN introduces the 400-cycle Companion-Trip® Circuit Breaker.

Special design and metallurgical features overcome previous limitations, and Companion-Trip—a new principle—provides complete phase isolation.

The new aircraft type circuit breaker is hydraulic-magnetic, of course. Current carrying capacity and set tripping points are completely unaffected by ambient temperature.

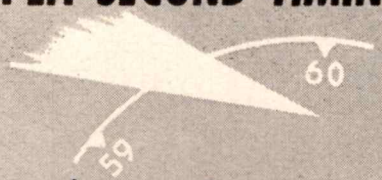
Moreover, a selection of time delay response curves permits overload protection to be fitted to the precise requirements of your equipment.

For complete information, request Bulletin T-3301.

HEINEMANN *Circuit breakers*

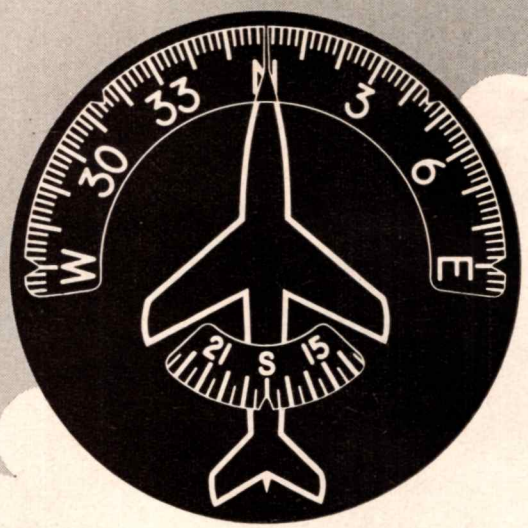
HEINEMANN ELECTRIC COMPANY
114 Plum Street • Trenton 2, New Jersey

WHERE SPLIT-SECOND TIMING



may depend on

.001" ACCURACY



"U. S. RADIUM" has been recognized since pre-World War II by both industry and government as the major source of supply for precision-made dials, functional instrument panels, and quality nameplates.

"MICROSCOPIC-PRECISION", most essential for performance and safety in aviation, actually defines the minute accuracy of "U. S. RADIUM" made dials. Nothing is left to guess-work — every step of production is "microscopically" checked and painstakingly controlled to assure the highest degree of accuracy humanly or mechanically possible. *Perfection based on experience is the result.*

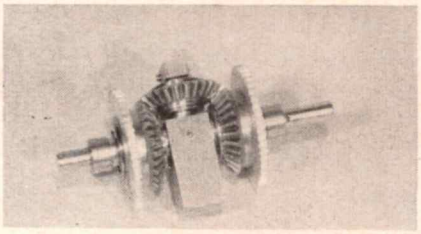
IF PEAK PERFORMANCE IS IMPORTANT for *your* dials and panels, it will pay you to take advantage of our years of engineering and production experience.

Write to Dept. AD-10

US RADIUM

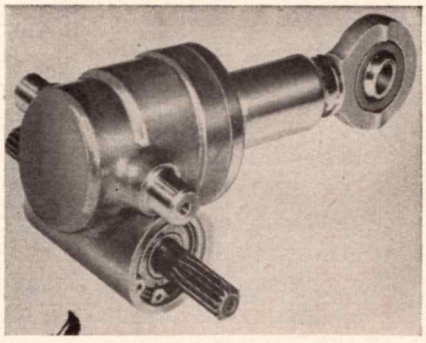
UNITED STATES RADIUM CORPORATION
535 Pearl St.
New York 7, N. Y.

any other reciprocating engine aircraft. It weighs 17½ lb. without cushion. This 40G seat conforms to MIL-S-7832 class "B" specification, with additional strength provision for 40G at 20 deg yaw load. The seat will assume all loads, with none transferred to the airframe structure. It has five in. vertical travel. As used by Beech, the seat has Type MA-1 inertia reel mounted on back frame and pan structure.



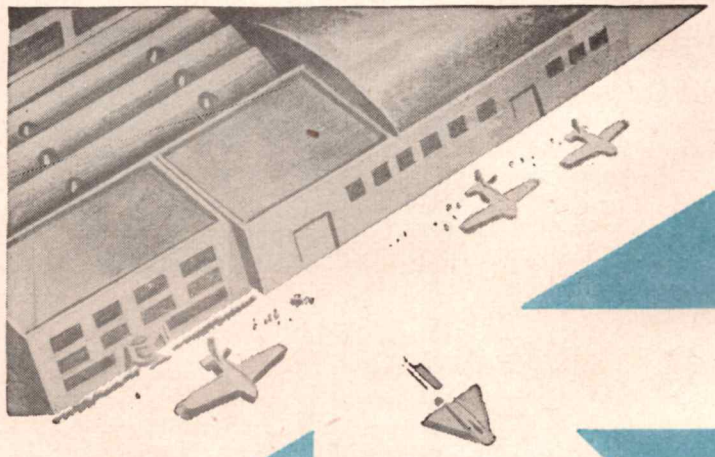
Computing Differential

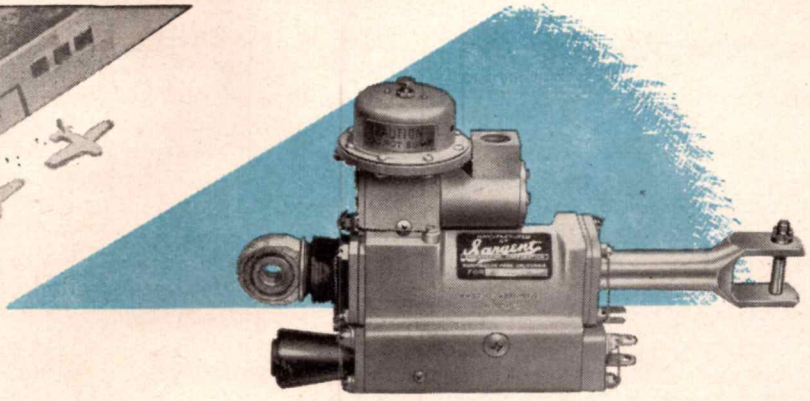
The ⅛ in. differential is the latest addition to Ford Instrument Co. line of single spider-gear differentials. Designed to meet military and commercial standards, this unit mechanically adds and subtracts with high accuracy, and has many airborne uses. The differential can operate over a wide environmental range, weighs less than one oz., and performs in a working circle of one-in. maximum diameter. Breakaway torque at no-load is 0.001 oz-in., which value is consistent with the differential's high sensitivity. The unit is made of stainless steel to ensure low wear and high corrosion resistance.



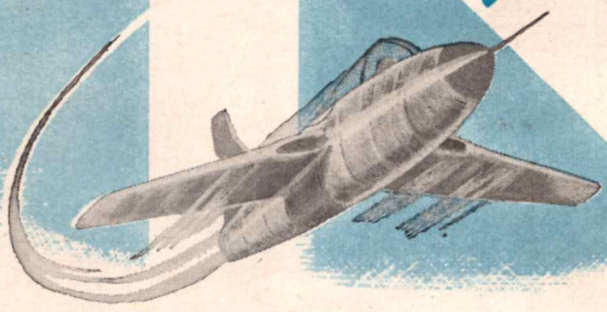
Screwjack

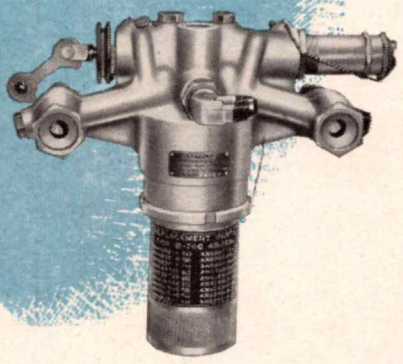
A new aircraft screwjack has been developed by Lear, Inc., to meet the increasing need for a compact, lightweight unit capable of high load actuation while acting as a heavy-duty structural member. Designated Model 586, the new unit features maximum operating loads of 3500 lb. compression and 1200 lb. tension, and is cap-





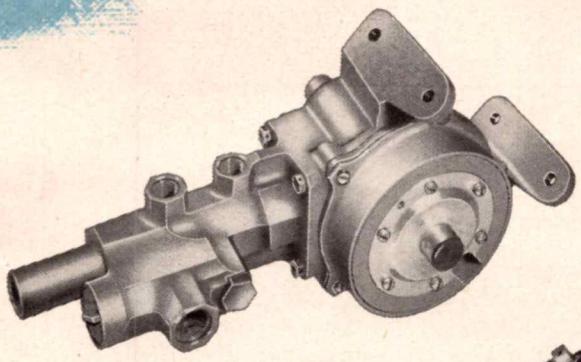
Aircraft hydraulic and mechanical controls by Sargent





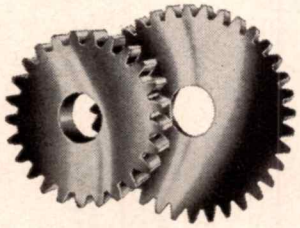
Sargent has been building *dependable* hydraulic and mechanical controls since 1920. Today, leading builders of military and commercial aircraft recognize Sargent's *undivided responsibility* in research, engineering and manufacture as the standard of excellence for the production of these components.

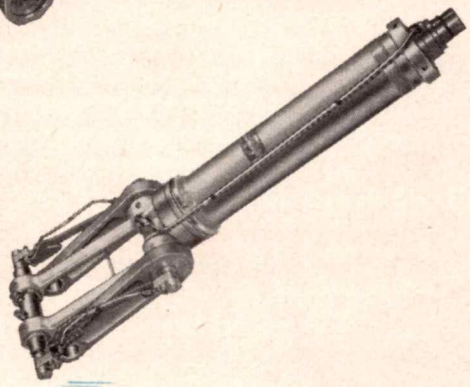
The story of Sargent's organization, methods, and manufacturing facilities will show you how Sargent can work for you profitably and efficiently. Why not write today for your copy of the Sargent Aircraft Brochure?



SARGENT BUILDS

Aircraft Power Control Assemblies • A Complete Line of Gears and Gear Assemblies • Actuating Cylinders • Shimmy Dampeners • Servo Valves • Sequence Valves • 3-Way and 4-Way Selector Valves • Directional Valves • Relief Valves • Pressure Regulators Brake Valves • Pressure Reducing Valves



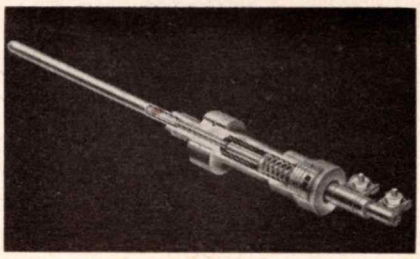


Standard of Excellence — Sargent — *Since 1920*

ENGINEERING CORPORATION
2533 EAST 56TH STREET
HUNTINGTON PARK, CALIF.

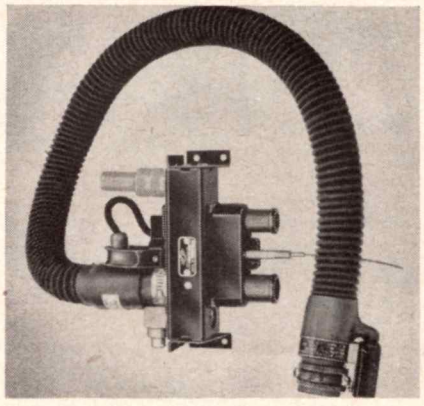
"Good will" is the disposition of the pleased customer to return to the place where he has been well treated.
— U.S. Supreme Court

able of withstanding static loads of 7000 lb. tension and 8000 lb. compression without deformation. In spite of its high load capacity, the new screwjack weighs only 1.1 lb. and is especially suitable for applications where restricted installation space is a limiting factor. Typical applications are leading edge flaps, trailing edge flaps and dive brakes. The centralizing Acme screw of the new unit is precision ground from a high-grade forged alloy steel specifically selected for the long life and high impact resistance under temperature extremes. Close tolerances assure a minimum of end-play. A long engagement nut minimizes working pressures on critical tooth surfaces. Special ball bearings, lubricated for life, are utilized as compression thrust bearings. Worm gearing is mounted in shielded ball bearings for maximum protection against extreme environmental conditions. Operating temperature range of the unit —65 deg. F. to 250 deg. F.



Thermal Switch

Control Products, Inc., is now in full production on the new two-wire type super high temperature thermal switch. It is designed to give excessive temperature warning to 2000 deg. F, such as in gas turbine engines and afterburners. It is a non-grounded switch and has maintained set calibration for 100 hr. at 1500 deg. F with a variation of only 10 deg. F. The switch weighs only six oz., is constructed of stainless steel and contacts are welded on flexing type arms for long life.



Personal Leads Disconnect

Designed to facilitate safe ejection from highspeed aircraft, the Aerotec D-300 personal leads disconnect provides an automatic severance of the oxygen, g-suit and communication lines during an emergency ejection from aircraft. As the seat is ejected, tension on the lanyard releases the locking mechanism and allows the upper and lower assemblies of the D-300 to separate from the bracket. The lower assembly remains with the aircraft while the upper assembly is ejected with the pilot and is prevented from flailing by means of clips attached between the hoses and the flight suit. In case of an alert, the pilot connects all his personal services by one motion of sliding the upper assembly into the bracket. The D-300 contains provisions for a bail-out oxygen supply. The units are designed to prevent water from entering the oxygen or g-suit hoses in the event the pilot descends into the sea.

2 feet to safety

With pressure from the pilot's feet, tons of metal are brought to a fully controlled safe stop. Planes are landing faster and hotter, but with continually improved mechanisms such as Gladden's brake control units, greater power to control and stop is now possible. Gladden's ability to anticipate the requirements of the aircraft industry has made them a leader in the manufacture of brake control units. Today Gladden is in quantity production on the three major types of brake control units . . .

- Master brake cylinder
- Power boosted master brake cylinder
- Power brake valve

Over 15,000 power boosted master brake cylinders now in service.

Consult Gladden engineers on your hydraulic design problems.

POWER BOOSTED MASTER BRAKE CYLINDER

Gladden

OFFICES IN PRINCIPAL CITIES

Midwest representative:
GEORGE E. HARRIS & CO., INC.
1734 No. Hillside
Wichita, Kansas

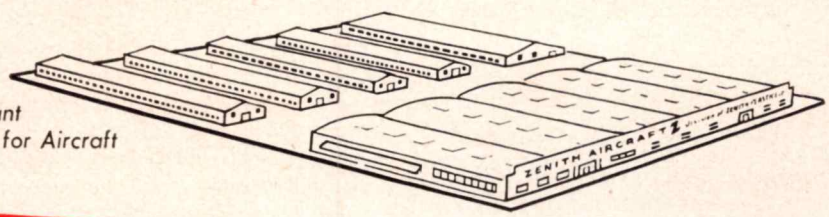
Dallas, Texas
Kansas City, Mo.
St. Louis, Mo.
Ft. Worth, Texas
Cedar Rapids, Iowa

Eastern engineering and sales office.
509 Tasker Street
Ridley Park, Pa.

GLADDEN PRODUCTS CORP., 635 WEST COLORADO BLVD., GLENDALE 4, CALIFORNIA

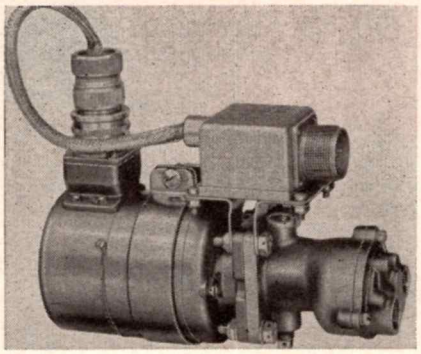
"futures unlimited" with ZENITH AIRCRAFT

The sky is literally the limit with the new, vastly expanded facilities for reinforced plastic production of Zenith Aircraft—Division of Zenith Plastics Co. New ideas—new developments—tremendously broadened horizons in Radar and Electronic applications, Guided Missiles and primary structures in aircraft—will result from Zenith's continuous program of research. Write for brochure "Futures Unlimited" for a picture of progress and a glimpse of a future without limitations, to Zenith Aircraft, Division of Zenith Plastics Co., Gardena, Calif.



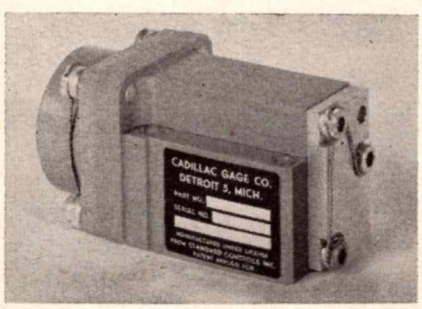
World's Largest Plant
devoted to the production of Reinforced Plastics for Aircraft

ZENITH AIRCRAFT Division of Zenith Plastics Co. **Z gardena, calif.**



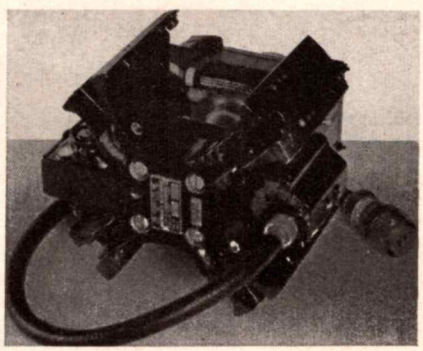
Hydraulic Pump

The total weight of the Lear-Romec Model RG-10430 is only 5.5 lb.—reflecting the unusual unit compactness of electric motor, rotary gear pump, pump adapter and radio noise filter. The rotary gear pump is extremely small, but it has the same speed as the motor and displaces ½ gpm at 1000 psi. This element is a complete pumping component attached to the motor-pump adapter with three screws. The fluid may be hydraulic oil or engine lubricating oil. A self-adjusting seal assembly is installed in the adapter which contains drain port and vent. Motor is 0.44 hp, 26 volts dc, 23 amperes and explosion proof. It is designed to Specification AN-M-40. The pump-motor unit is assembled as RG-10430C without the radio noise filter and weighs only 5 lb. The filter limits interference to 0.15 to 150 mc per MIL-I-6181. The motor is rated for intermittent duty of 3 min. on, 20 min. off when pump is operating at 1000 psi discharge pressure. On personal aircraft it operates at 500 psi with aircraft engine oil to actuate the propeller pitch.



Servo Valve

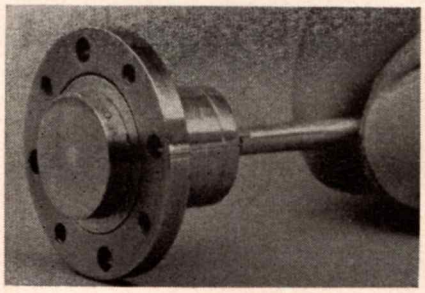
The Cadillac Gage Co. FC2 Flow Control Servo Valve regulates the rate of flow of hydraulic fluid proportional to an electrical input signal. The principle applications of this valve are in servo-mechanisms where high dynamic performance is required at high power levels. A new concept is used in the FC2 valve to control the position of a 4-way slide valve. A miniature servo contained in the valve operates at a high force level to provide accurate control of slide valve position proportional to the electrical input signal. This closed loop operating principle assures excellent flow regulation over a wide range of supply pressure and environmental operating conditions. The FC2 valve possesses excellent static and dynamic performance characteristics. In addition it offers a unit of high quality and rugged construction in a small and lightweight package.



Linear Actuator

Designed for smooth, positive wing-flap control on jet aircraft, the Air Associates M-5250M1 actuator is mounted adjacent to the flap (one actuator in each wing). Units are interconnected through flexible shafting and a coupling.

Characterized by its fast-stopping action, this actuator can arrest the flap in any position within its operating range. A magnetic clutch-brake is incorporated into the unit to minimize coasting when actuator is de-energized. Several limit switches afford a high degree of control. Position limit switches govern stroke at extended position and mid-position, and a combination position-limit-switch and load-limit-switch is effective at retracted end. The unit also features stall-load limit switches which prevent wing-structure overloading beyond 3600 lb. A basic design, the M-5250M1 can be modified to fulfill requirements of other aircraft control applications.

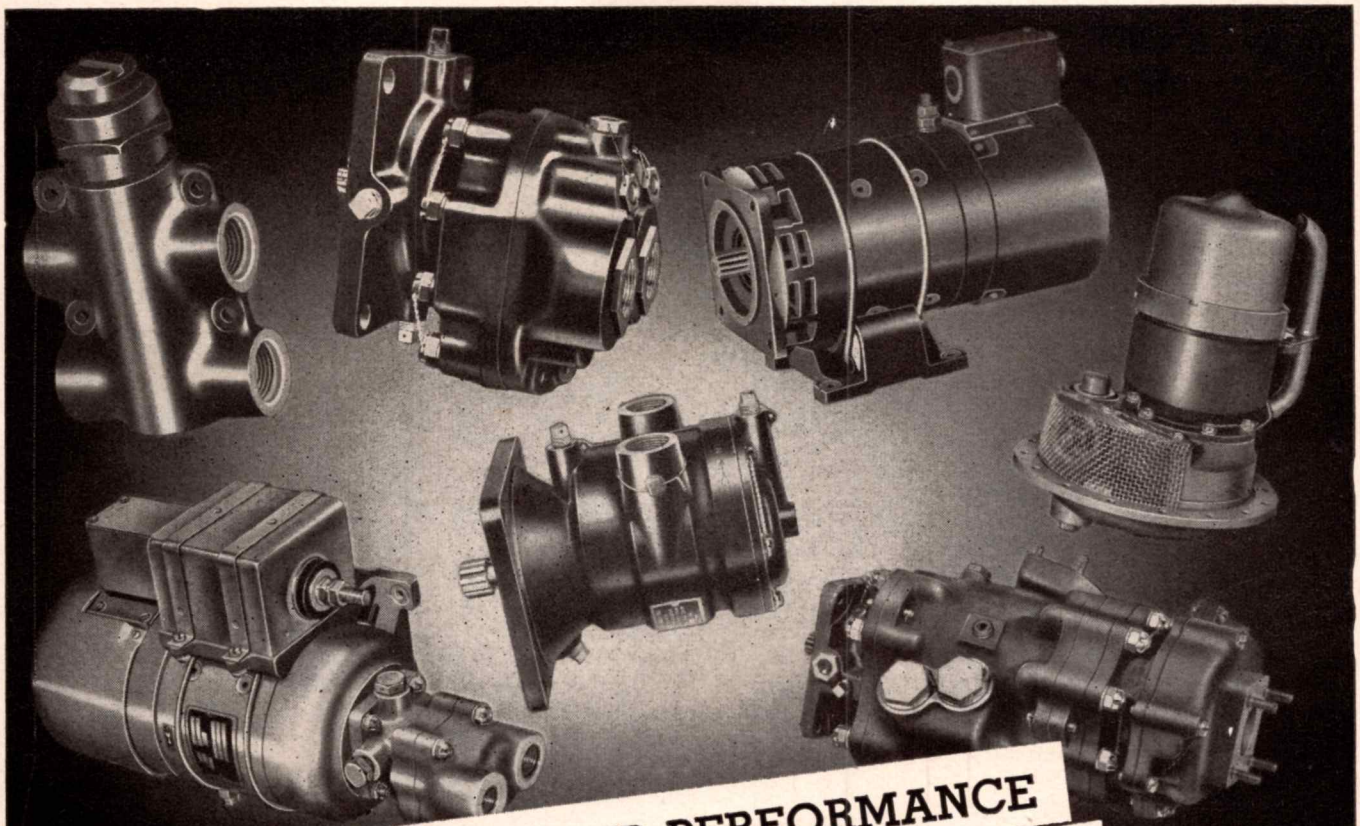


Pressure Pickup

Where pressure transients occur too rapidly for observation with conventional indicating devices, the new Consolidated Engineering electrical resistance-Type 4-312 Pressure Pickup provides immediate response to pressure changes. This latest of Consolidated Engineering's miniature pickups is available in gage, absolute, and differential models which feature high corrosion resistance and a flush-type diaphragm. It may be used for either liquid or gaseous measurements. Absolute models are available in 10, 15, 25, 50, 100, and 150 psia ranges. Differential models are supplied with ranges of plus or minus 5, 7.5, 12.5, 25, 50, and 75 psid, and are usable with maximum line pressures of 150 PSI. Upper limits of gage pickups are 5, 10, 25, 50, 100, and 150 psig. Other ranges are available on special order. Pickup weight is only 20 grams. Diameter and length are 0.5 in. by 0.75 in. Each pickup is individually calibrated and supplied with a calibration certificate. A variable-resistance unit incorporating a 4-arm bridge, the 4-312 converts changes of pressure against the diaphragm to proportional changes in voltage output. The output can be permanently recorded with a recording oscillograph or visually observed on an oscilloscope or meter. Alarm, cut-off, and control circuits can be actuated by amplified output. Overloads to 250 percent of full scale can be tolerated without damage.

Precision Cams

Ford Instrument Co. has a wide variety of cams—for practically any kind



FOR DEPENDABLE PUMP PERFORMANCE
THERE IS NO SUBSTITUTE FOR PESCO!

A BORG-WARNER B-W INDUSTRY

There is no substitute for Pesco's twenty years experience in producing hydraulic, fuel, and air pumps for every type of aircraft. Continuous research and development have provided thousands of Pesco models with operating characteristics that are continually establishing new high standards of performance.

In addition, there is no substitute for the extensive facilities at Pesco. These include advanced engineering, exhaustive development testing, and high precision production—all geared to provide the *one best* product for your specific requirements.

It will pay you to investigate these Pesco advantages. Simply write or call the Main Office, Bedford, Ohio.

YOU CAN RELY ON

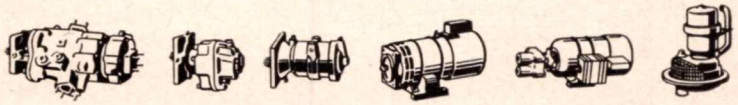
PESCO *Pressure Loaded* PUMPS

FOR THESE ADVANTAGES

DEPENDABLE PERFORMANCE
•
AUTOMATIC ADJUSTMENT FOR WEAR
•
LESS INSTALLATION SPACE REQUIRED
•
LESS MAINTENANCE

Call or write the Home Office, Bedford, Ohio for full information on these Pesco products as applied to your specific installation.

HYDRAULIC PUMPS	•	FUEL PUMPS
AIR PUMPS	•	POWER PACKAGES
ELECTRIC MOTORS	•	BOOSTER PUMPS



engineering Pesco production

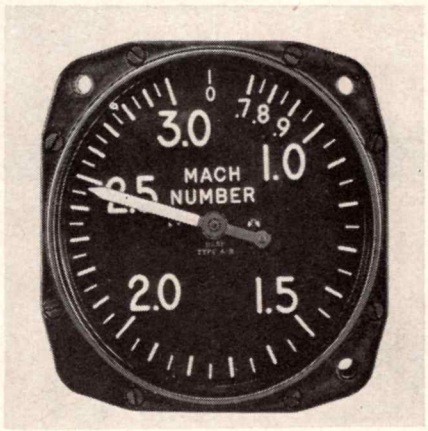
PRODUCTS DIVISION

BORG-WARNER CORPORATION

24700 NORTH MILES ROAD • BEDFORD, OHIO

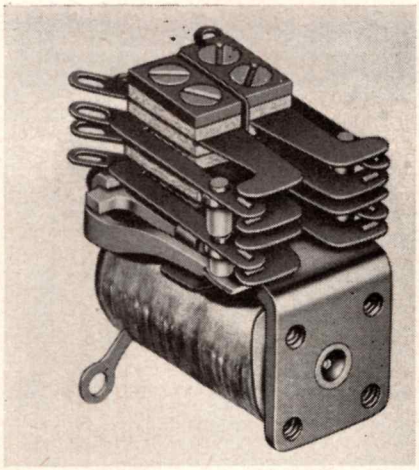
of application. They are especially valuable as compact mechanical, "memories" for analog computers and similar systems. The cams can be manufactured as "packaged units," complete with followers and all necessary gearing, mounted and ready for the user's system—or cams can be supplied alone, to be mounted by the user.

The cams fall into two major groupings: three-dimensional cams and single-input. The 3-D cams make available a compact unit which continuously and accurately satisfies an arbitrary function: $z = f(x,y)$, where x and y are independent variables, and z is the output. Tolerances are as close as $\pm$ 0.0005 in. A wide range of materials is available. Single-input cams include grooved flat cams, external flat cams, and grooved cylindrical cams.



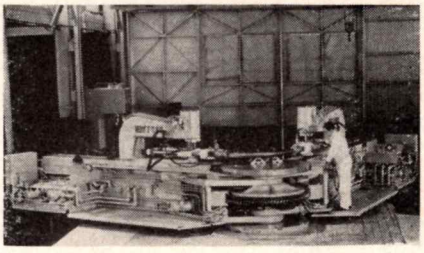
Supersonic Machmeter

The Kollsman Instrument Co's. supersonic machmeter, used in high speed research flight, directly and continuously indicates Mach number within the range of 0.7 to 3.0. This instrument has been particularly important in several record breaking flights, the most recent of which was that of the U. S. Air Force's Rocket Plane X-1A which Major Charles E. Yeager flew at about 1650 mph at nearly 80,000 ft. The machmeter is operated by the impact and static pressures furnished by a pitot tube. A differential pressure diaphragm and an aneroid diaphragm are the sensing elements of the mechanism. The deflections of these diaphragms operate on a lever system. The resulting movement is transmitted by a gear train to the pointer, giving a continuous visual Mach indication.



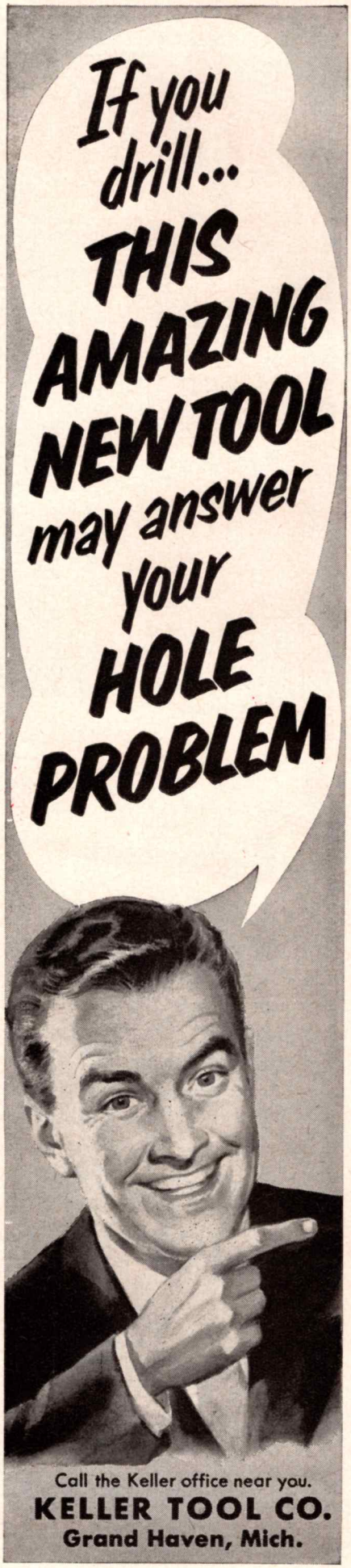
Telephone Type Relay

Advance Electric and Relay Co. announces its new TQ miniature telephone-type d-c relay for applications where space is drastically limited. The unit is only 0.94 cu.in. in volume and weighs just 1.2 oz. It is available in contact combinations up to 6PDT. It is vibration resistant up to 10g. The new relay uses only one air gap in the magnetic assembly and a retaining spring which maintains the armature rigidly in place on three major axes. This design eliminates the hinge pin, making the unit frictionless. Welded crossbar contacts are employed, assuring positive alignment of contacts at all times. The unit operates at 90 milliwatts or less, has a current rating of three amps resistive, one amp inductive at 26½ v d-c. The unit handles a temperature range of —55 deg. C to 85 deg. C with standard coil, and —55 deg. C to 125 deg. C with a teflon coil. Life expectancy is one million cycles minimum.

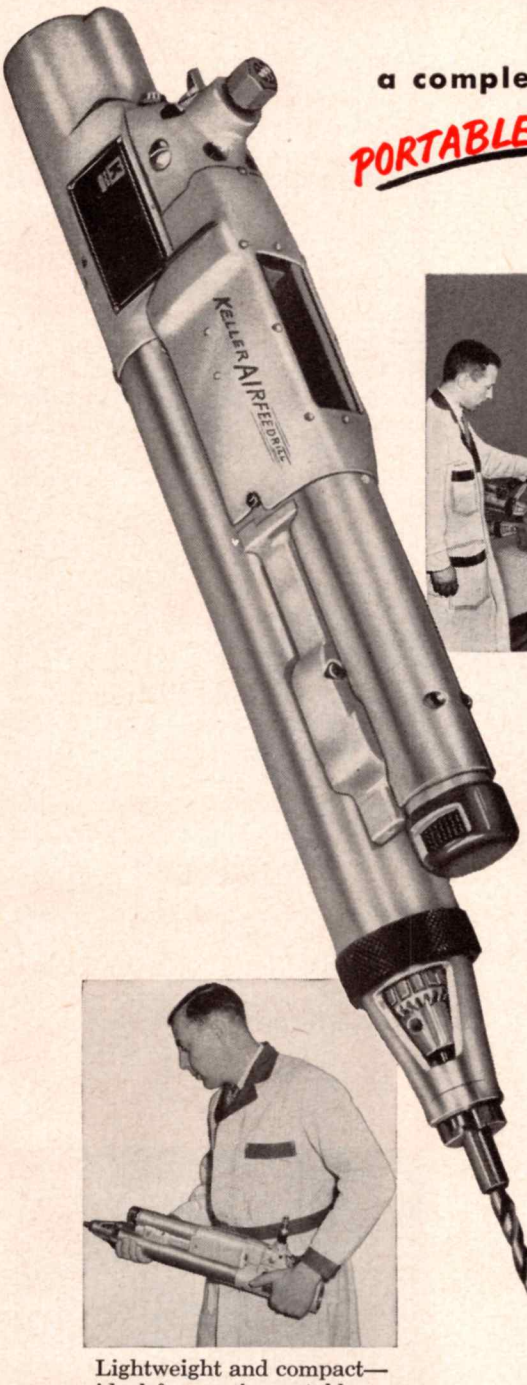


Carousel Stretch-Wrap Forming

A new stretch-wrap forming machine featuring full 360 deg. arm rotation has been announced by Hufford Machine Works Inc. It was designed in conjunction with Douglas Aircraft Co. With its 360 deg. arm rotation around a stationary die and table the Carousel model forms full circles. In addition, the stretch-wrap forming operation can be complemented with a following


If you drill...
THIS AMAZING NEW TOOL may answer your HOLE PROBLEM
Call the Keller office near you.
KELLER TOOL CO.
Grand Haven, Mich.

Announcing



a completely AUTOMATIC, self-contained, PORTABLE drilling unit with advantages you expect only in expensive machine tools

Peck drilling four deep holes in a magnesium casting

THE NEW SERIES 92A KELLER "AIRFEEDRILL"

—locks to any jig or fixture, and drills accurately. Stationary mounting brackets available

—operates automatically through the complete drilling cycle—advances, drills, retracts, shuts off—at a single pressure of the control valve

—handles peck drilling and skip drilling

—gives complete control over motor speed, drilling speed, torque, rate of advance, and depth of hole

Lightweight and compact—ideal for use in portable or stationary applications

It has these operating features:

SENSING TYPE RAPID ADVANCE brings the drill point quickly to the work, then drops instantly to the drilling rate.

TORQUE CONTROL causes automatic retraction as often as necessary to clear chips during peck drilling. It also protects drills and indicates when they need sharpening.

FEED CONTROL permits adjustment to varying drilling conditions, as well as the material being drilled.

VARIABLE SPEED MOTOR controlled by throttle valve . . . shuts off automatically at end of drilling cycle.

These and other features mean that you can tool up for a few hundred dollars . . . instead of thousands. Send for Catalog Section 92 which fully describes and illustrates this remarkable new tool.

KELLER "Airfeedrill"

SERIES 92A

KELLER TOOL COMPANY, 1315 Fulton St., Grand Haven, Mich.

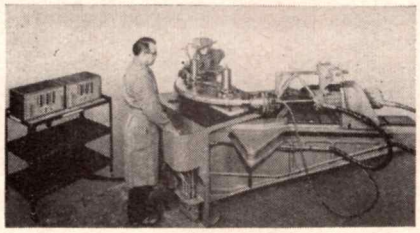
roller or wiper which operates simultaneously. This roller, attached to one of the rotation arms, may be operated clockwise or counter-clockwise and is unlimited in the number of passes which can be applied to the work. Other Carousel operations include bulldozing, joggling, stretch-straightening, forming reverse bends and "S" curves. Arm brackets supporting tension of cylinders are power driven along the arms. Each rotating arm is under independent control and can be operated at variable speeds in either direction. Controls are provided for each arm and are contained within a pair of steel boxes with cable attachment. A quick plug-in connector enables both control panels to be used on the same arm under the eye of a single operator, or one control panel can be used on each arm with dual operators. Cycling of various movements is by push-button control. All operations are hydraulically actuated, with the exception of manual raise and lower of the two tension cylinder adjustments.

B·H

fabricators for the aircraft industry

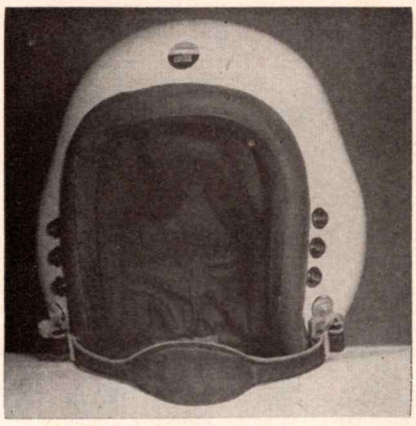
B.H. AIRCRAFT CO. INC.

FARMINGDALE, NEW YORK



Electronic Counter

A problem common to many types of forming operations has been variables in work-hardness characteristics between different batches of the same stock. As a result, factors established in the forming of a product from one batch must often be readjusted as a new stock supply is received. A new system of controlling amount of stretch has been developed for use on the Hufford stretch-wrap forming machines by Hufford Machine Works Inc. The mechanism is relatively simple, using two electronic counters. Attached to each tension cylinder is a mechanical device which measures jaw retraction. This consists of a disk marked with a series of alternate black and white lines radiating from the center. The disk is rotated by contact with the sliding arm attached to the jaw. Each 1/10th in. of ram travel causes one white line on the disk to pass an aperture. A light beam reflected by each white line is picked up by a photo cell and converted to an electrical impulse. Thus a series of single electric impulses is transmitted from each arm to its respective electronic counter. Arriving at any desired jaw retraction becomes very simple. The desired stretch is "punched" on the electronic counter keyboards in inches and tenths. When this total is counted off, the stretch is automatically halted.



Anti-noise Helmet

In the field of noise protection a new item has been developed by the

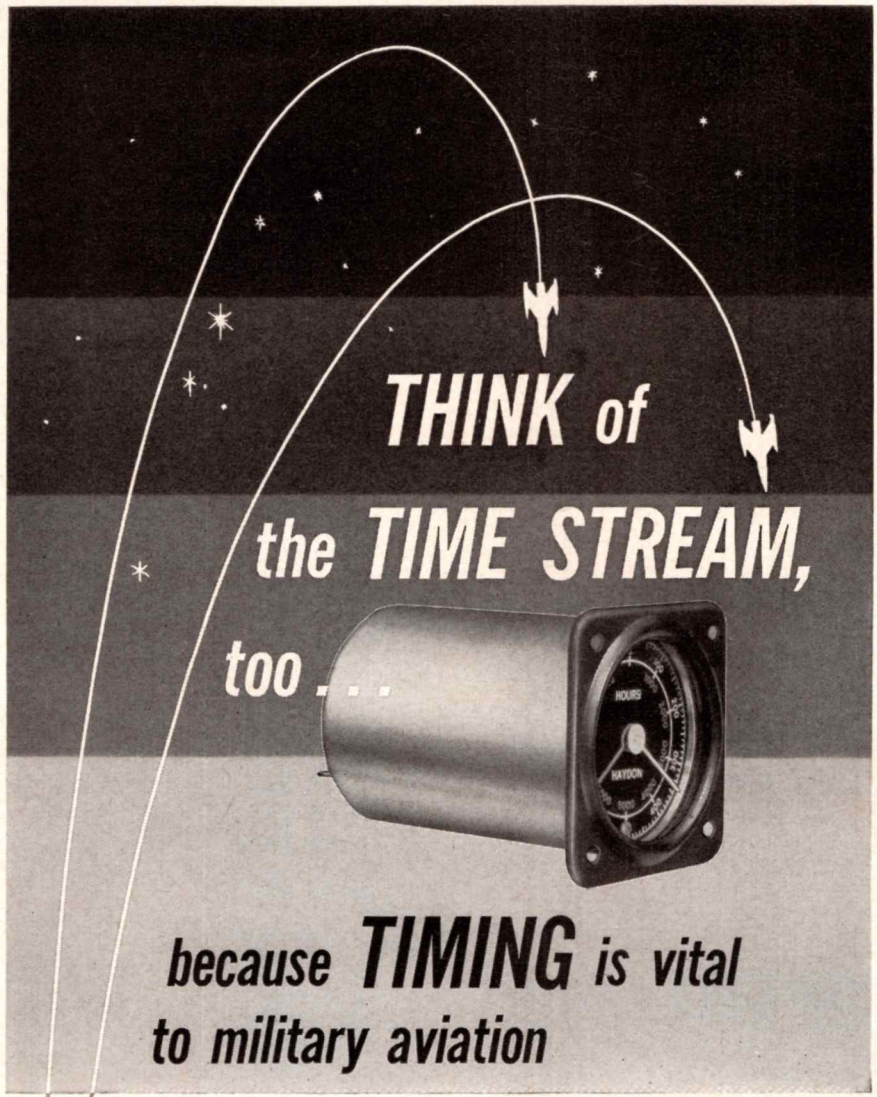
from design to delivery.....

you can rely on Weber for dependable aircraft equipment. This has been proven by the many products in service today for the Armed Forces and commercial airlines. Requirements for all types of fixed and ejection seating are being fulfilled in new aircraft. Call on Weber Engineers for help on your aircraft equipment problem. You can depend upon their solution.

WEBER AIRCRAFT CORPORATION

2820 ONTARIO ST. • BURBANK, CALIFORNIA • THORNWALL 8-5543

Subsidiary of Weber Showcase & Fixture Co., Inc.



because TIMING is vital to military aviation

AIR STREAM . . . JET STREAM . . . TIME STREAM. Knowledge of all is essential if you design or manufacture military aircraft or components.

For controlled measurement of time intervals on airborne equipment, as in the running time meter illustrated, the small yet rugged mechanisms in HAYDON Timing Devices track with precision and accuracy.*

Use our facilities and skilled personnel to help you find the answers to your aero-timing problems. Call in the factory-trained HAYDON Field Engineer near you; or write to us outlining your requirements — and ask for catalogs on Timing Motors and Devices.

HAYDON Elapsed Time Meter, Series 7008: 400 cycle a-c, hermetically sealed. Barrel diam., 1.525"; length, 2-45/64"; weight, 6 oz. Power consumption less than 3 watts. Indicates in units of 10s of hours up to 10,000, and repeats. Request "Engineering Bulletin No. 4".

**Trademark Reg. U.S. Patent Office*

HAYDON AT TORRINGTON

HEADQUARTERS FOR **TIMING**

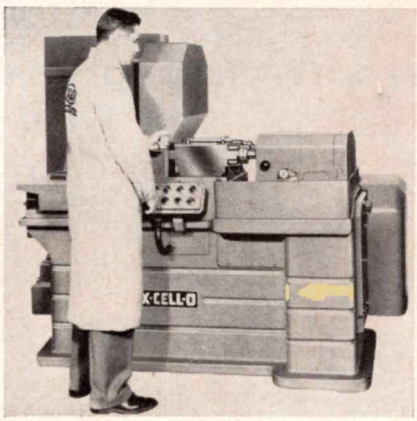
A SUBSIDIARY OF GENERAL TIME CORP.

HAYDON Manufacturing Company, Inc.

3534 ELM STREET, TORRINGTON, CONNECTICUT

AVIATION EQUIPMENT

Bill Jack Scientific Co. which offers an impact and penetration resistant head covering. The Sound-Asorb helmet is for use in engine test cells, around run-ups . . . wherever the ambient noise level approaches or surpasses the threshold of pain. The helmet has accommodation for standard intercommunication earphones and allows clear hearing, even in ambient noise levels of 150 db. It is also being used as a flight helmet.



Boring Machine

Ex-Cell-O Corp. has added a new model to their line of precision boring machines. The new machine is cam operated, and is built for such precision finishing work as contouring, boring, turning, facing and grooving. Cam followers impart the rise and fall of the cams directly to the machine table and cross slide—there are no levers. The machine is designed to accommodate parts that can be rotated on one or more spindles while the non-rotating tools are supported on the cross slide. This machine is ideal for production contouring work in which forms must be reproduced over and over again within close tolerances. Such forms can be inspected by checking only one dimension, because accuracy and relationship of other dimensions are determined by the cams.

The contour form is obtained by the longitudinal movement of the machine table coordinated with the lateral movement of the cross slide. The table carries the spindles with their drive equipment, is operated in rapid traverse by a pneumatic cylinder cushioned by oil. The feed portion of the table stroke is actuated by a cam opposed by an air cylinder. All cross slide movements also are produced by a cam opposed by an air cylinder.

technical bulletin

EEMCo

a New SLAT ACTUATOR for Jet Fighters

Another linear actuator that performs a special function on latest sonic jet aircraft is this compact new model that was designed, tested and produced by EEMCO for one of the major air frame manufacturers. It is one of many types of EEMCO linear actuators that can be adapted to other uses according to specific needs as to load, length of stroke, rate of travel, or other characteristic. In adapting one of EEMCO's production models much valuable development time and expense can be eliminated.

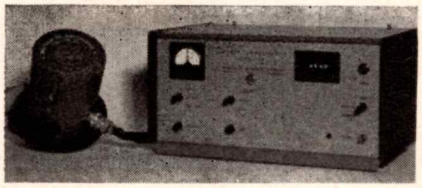
TYPE D-649 SPECIFICATIONS

Weight: 13.75 lbs. **Stroke:** 3 3/16 inches.
Working Load: 3400 lbs. normal tension; 8200 lbs. maximum tension.
Speed of stroke with 3400 lb. load: .55 inches per second on 28 volt DC system.
Maximum Static Load: 18,750 lbs. tension.
Load Limit Switch Actuation: on at 7500 lbs.; off at 9000 lbs.
Flexible Shaft Drive Take-off: non-jamming end stops with retraction stop adjustable within ¼ inch.

Designers and producers of motors, linear and rotary actuators.

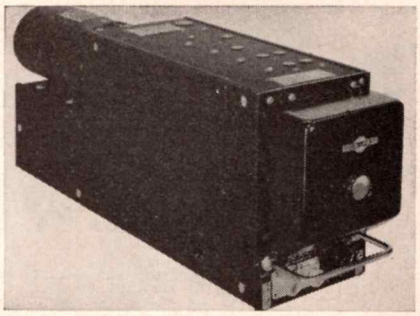
Electrical Engineering and Manufacturing Corp.

4612 West Jefferson Boulevard
Los Angeles 16, California



Pressure Balance

Fast, accurate, non-manual measurement of precision pressures is accomplished by the New Precision Pressure Balance recently released by Consolidated Engineering Corp., West Coast engineers, designers, and manufacturers of instrumentation. The new instrument makes obsolete the use of the 300 year old standard for precision measurement — mercury manometers. The Precision Pressure Balance, Type 37-103, provides a laboratory standard for precise calibration of pressure pickups, with accuracy comparable to the highest quality manometers. A visual, digital readout counter with digits to 1000 makes immediate readings possible. The instrument is designed so that readings may be held when required or attached to electrical tabulating devices through a built-in electrical analog d-c output of 10 volts. The pressure pickup is engineered so that three types of readings are possible—differential pressure, gage pressure, and absolute pressure.



They're in stock when wanted at UNIVERSAL

Whether you order Army-Navy approved clamps bare (AN 742 series) or the new cushioned MS 21919, Universal's quantity runs assure quick delivery and "on-spec" characteristics at all times. Available in carbon steel, aluminum alloy and stainless steel. Note the large, easily read type identifying the clamp—time saver in both production and stockroom.

UNIVERSAL'S years of design and production of airframe components establishes this company as a major source for tool making, stamping, welding, sub- and finished assembly. (Home of the famous Universal Aircraft Fuel Filler Caps.)

Nationwide service. For clamps—all sizes and types—*contact UNIVERSAL*

A WORLD OF KNOWHOW

TOOLS • DIES • METAL STAMPINGS • AIRCRAFT PARTS

Universal

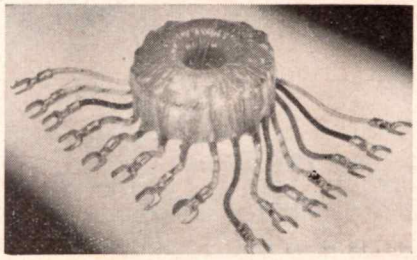
METAL PRODUCTS, INC.

2311 West Orange Street,
Alhambra, California
CUmberland 3-3115

Kansas City, Mo. Branch: Congress Building, 3527 Broadway

Collins Transmitter

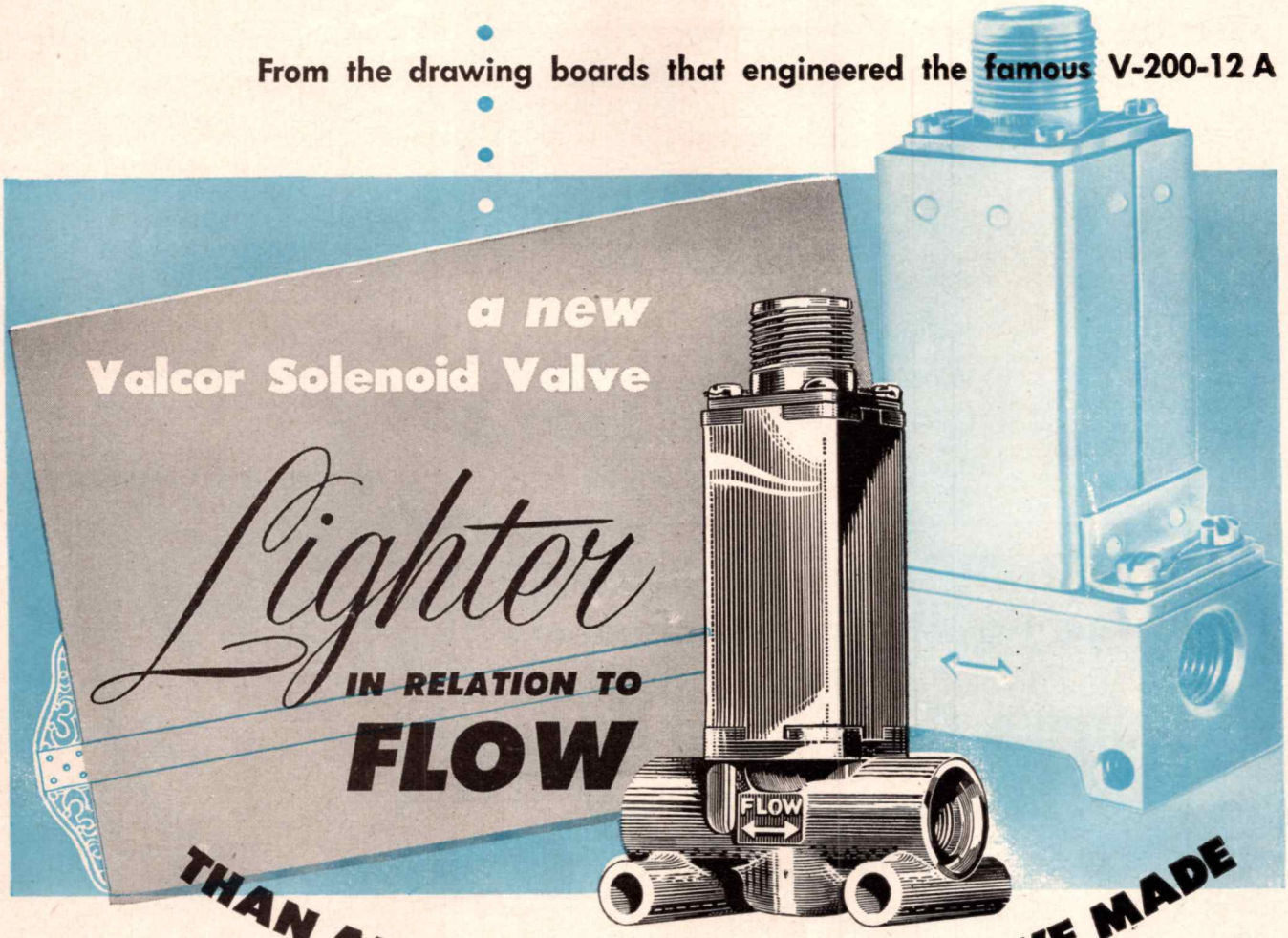
The Collins 17L transmitter provides transmitting facilities on all channels reserved for aircraft communication in the VHF band. Its frequency range is 118 to 135.95 mc and all of the 360 channels assigned in this range are easily selectable over a simple and positive remote control system. The power output on radiotelephone is 25 watts, assuring its reception at even the busiest air terminals. The total of 360 channels is furnished by a crystal-saving system employing two banks of crystals. The output of the two oscillators is filtered to remove undesirable harmonics, and then mixed. After mixing it is passed through a selective amplifier system to remove undesired mixer products, then tripled. Two well-isolated stages, a pre-amplifier and a driver, bring the level up to produce ample drive for the final amplifier. The unit is 22.25 in. long, 4.906 in. wide and 7.75 in. high and weighs 29 lb.



Magnetic Amplifier

A rugged magnetic amplifier has been developed for flight control systems by Airborne Accessories Corp. The new magnetic amplifier, which uses a saturable reactor resembling an octopus, affords a means of amplifying feeble electrical signals generated by the dynamic air pressure instrument of the servo system into electric currents strong enough to operate equip-

From the drawing boards that engineered the famous V-200-12 A



THAN ANY OTHER SOLENOID VALVE MADE

The new VALCOR V-3900 is unique. The exceptional operating advantages of the VALCOR *floating seal* design has been improved even further . . .

New ruggedness at ½ the weight
New compactness at ½ the weight
New dependability at ½ the weight

Yet the same flow capacity as the V-200-12A.

This remarkable achievement means a greater freedom of design for the engineer than ever before. The VALCOR V-3900 is setting new standards of Solenoid Valve performance where low pressure drop and lightweight are a factor.

WRITE FOR DETAILED INFORMATION

VALCOR
SOLENOID VALVES

Design Features of the Valcor V-3900 Shut-Off Valve

- Weight: .33 lbs.
- Absolute Minimum pressure drop. Straight-through flow.
- Valcor Floating Seal (Gate Type)
- Simplicity of design
- 100% efficient seal in both directions
- Self lapping—self cleaning
- IMPROVED SOLENOID COIL—CONSTANT DUTY withstands shock, vibration and the elements.

SPECIFICATIONS

Operating voltage—18 to 30 V.D.C.
Current Drain—½ AMP @ 24 V.D.C.
Max. Operating Press.—100 PSI
Porting—AND10050-4
Other port sizes available either normally open or normally closed. Designed to conform to latest military specifications. Pat. Pend.

USES

Auxiliary power units
Fuel systems
Deicing Systems
Water Injection Systems
Cabin Pressurization
Heat & Vent Systems
In-flight refueling

VALCOR ENGINEERING CORP., CARNEGIE AVE., KENILWORTH, N. J.

ment directly or to energize relays for the same purpose. Since the unit uses neither fragile vacuum tubes, nor delicate relays and contains no moving parts, it is a more rugged and reliable device. The amplifier is used in synthetic "feel" systems. Variation in the electrical reading of the instrument moves the actuator, producing a corresponding adjustment in the mechanical loading system connected to the control column.

Electronic Gear Testing

ANGLgears, the standardized right angle bevel gear units made by Airborne Accessories Corp., are now individually tested with special electronic sound testing equipment for quietness of operation.

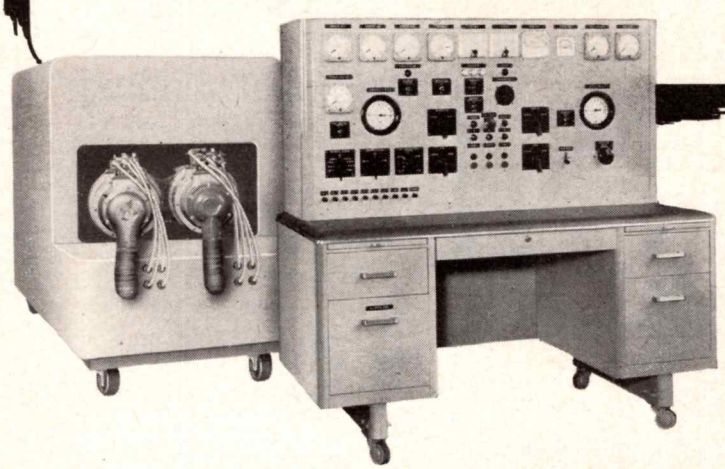
Airborne points out that the noise level is the best indication of the condition of the gears.

The new electronic testing equipment is not only an excellent inspection tool but is also helpful in gear assembly and as a research tool.

The ANGLgear comes in two standard models—a ⅓ hp and a one hp unit—both small enough to fit into a man's hand. Both are strong enough for use in power systems as well as for manual operation.

SAVE THOUSANDS OF DOLLARS
in testing Aircraft Generators
United's NEW FEEDBACK TEST STAND

- Eliminates Load Bank
- Simplifies Operation
- Cuts Initial Cost

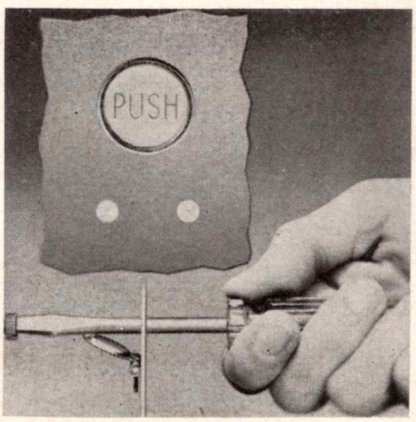


The wraps are off! United's new feedback test stand, a compact unit ⅓ to ½ the size and weight of conventional equipment, provides complete testing with up to 200% loading. No load bank is required, a saving in both initial cost and test space. The feedback drive uses less than ⅓ of the horsepower of an old-type test stand. A direct economy! Only two simple controls are used for all load and power factor changes. Automatic protection is provided for temperature, voltage, air pressure, faults, current and synchronization. Full details are ready for you.

Write us today for Bulletin FTS

UNITED AIRCRAFT TEST EQUIPMENT

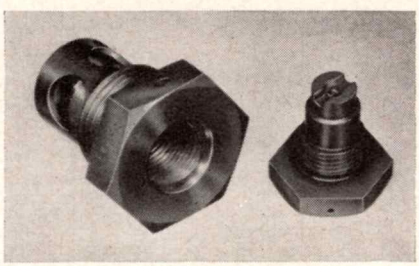
UNITED MANUFACTURING COMPANY
DIVISION THE W. L. MAXSON CORPORATION
41 HAIG STREET, HAMDEN, CONNECTICUT



Access Door

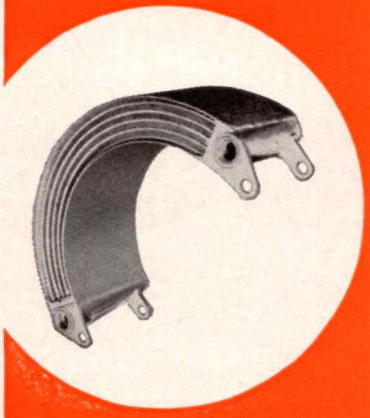
A spring-hinged access door KM-713, has been announced by Camloc Fastener Corp. Designed for use where a flush finished surface is essential, this device has a "captive" door that cannot separate from the surrounding panel. It is easily mounted by rivets, after drilling two rivet holes and a hole for the door opening.

The Camloc access door is recommended for use where frequent adjustments are made by screw drivers or similar tools and for lubricating points. It opens simply by pushing the door with the tool. The door automatically springs back into place when the tool is withdrawn.

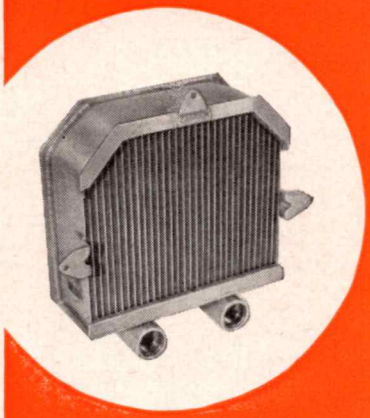


Magnetic Plug

The Technical Development Co. is manufacturing a new magnetic drain unit for reciprocating engine oil sumps,



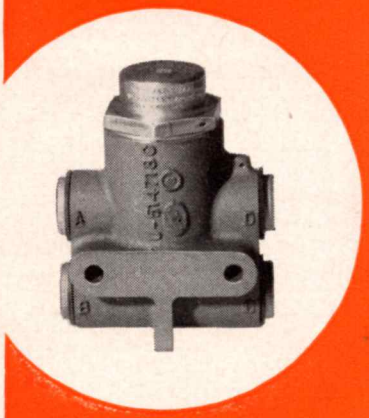
paralyzing temperatures *exchanged for* operating temperatures



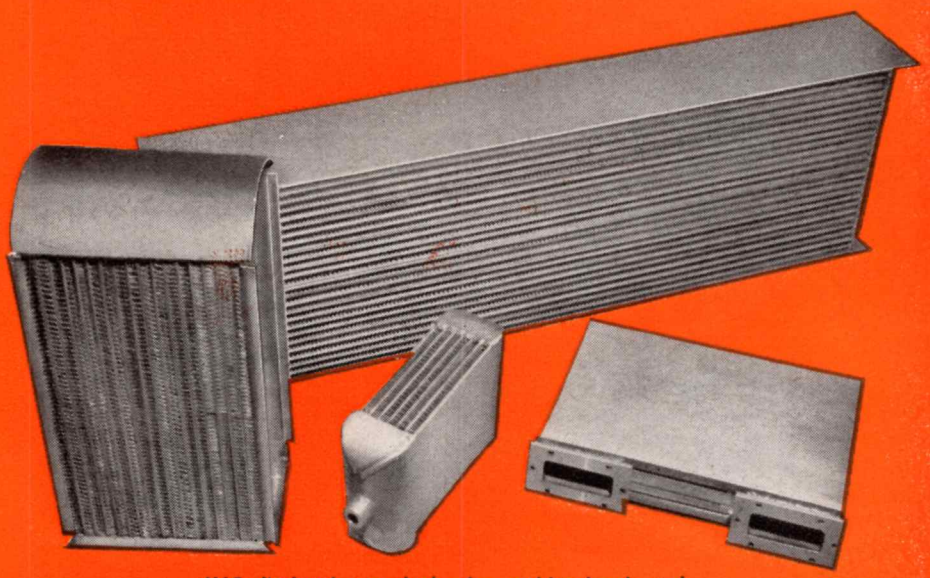
Engine and equipment requirements in heat exchange performance become more critical with each new design. Temperature limits are less flexible. Temperature controls must be more positive.

Flow control is a valve function. The capacity to exchange heat is the responsibility of the heat exchanger, and heat exchanger efficiency depends upon its ability to meet given space and weight limits with minimum power consumption.

UAP can meet your flow regulation and heat exchanger needs. UAP engineers can design to envelope limits — square, oblong, or segmental. UAP's 25 years of heat exchanger experience is your assurance of complete satisfaction!



There is a UAP Valve for each UAP Heat Exchanger.



UAP dip-brazing methods give positive bonds and clean passages in fin cores. For heat transfer packages that must meet new performance factors and conform to restricted envelopes, call UAP.

UAP — UNITED AIRCRAFT PRODUCTS, INC.

a famous family of aircraft essentials

UNITED AIRCRAFT PRODUCTS, INC.

1116 BOLANDER AVE. • DAYTON 1, OHIO

The 45 Pound Navigator

• **Modern jet aircraft** move at such a rate (one would go from Lexington to Concord, Massachusetts, in the time it takes you to read this column) that it is difficult for the pilot to keep track of his location. A few minutes flight off his course and he can be lost. He must constantly check his speed and direction to keep track of his position. In a military plane, a few minutes of dodging enemy action can carry him over completely strange territory.

• **A wonderful new instrument** (called the AN/ASN-6) which weighs only 45 pounds, is now being built to do this navigational reckoning for the pilot. Regardless of how much he turns and twists the plane, this "ground position indicator" constantly displays the plane's position — and gives the reading in latitude and longitude.

• **Developed for the Air Force** by the Ford Instrument Company, this new instrument occupies less than 1½ cubic feet, although it has almost 2,000 parts in it. To make it easier to mount in the plane, it is built in four units, connected by cables, so all of it doesn't have to fit into the crowded cockpit. Three of these units are hermetically sealed and are built to outlast the airplane. The fourth unit — the one with electronic parts which might wear out — is designed for easy replacement of parts by sliding them out and plugging new ones in.

• **Commercial air lines** whose routes are mainly over water and remote from airway beacons have shown a keen interest in this new instrument. And Ford Instrument Company is already hard at work developing even more wonderful advancements on this remarkable new device.

Each year Ford Instrument Company is adding to its staff of several hundred engineers. If you are an engineer and can qualify, there may be a position for you.

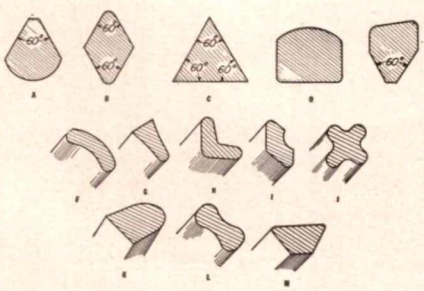
24

FORD INSTRUMENT COMPANY

DIVISION OF THE SPERRY CORPORATION

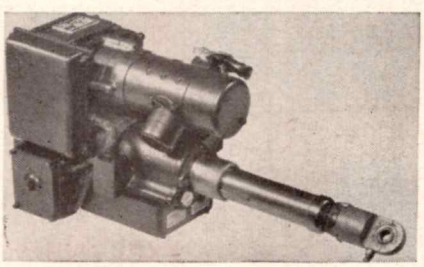
31-10 Thomson Ave., Long Island City 1, N. Y.

helicopter gear cases, jet accessory drives, and any similar applications. The assembly has a magnetic drain insert and a spring-loaded poppet-type valve. The magnetic drain insert picks up any metal chips present in the fluid and can be removed for inspection without causing leakage from the sump. This plug can be used with virtually any fluid present in aircraft. Its metal components are made of heat-treated aluminum alloy finished for resistance to corrosion and seizure. O-rings or metal asbestos gasket seals are available as needed for compatability with fluid lubricants of either mineral or synthetic nature.



Formed Wire

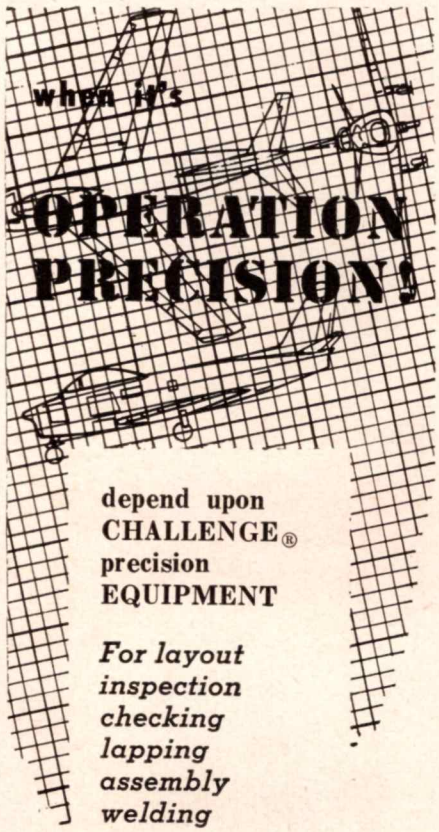
Heli-Coil Corp. has developed many intricate wire shapes for industry, some of which are shown in the accompanying drawing. This formed wire is available in sizes ranging from a maximum cross-section of 3/16 in. diameter down to a minimum of .015 in. diameter. Tolerances can be held to .0002 of an in. and surface finishes from 8 to 15 micro-in. can be produced. Hardness up to Rockwell-"C" 50 can be obtained in metals which can be work-hardened.

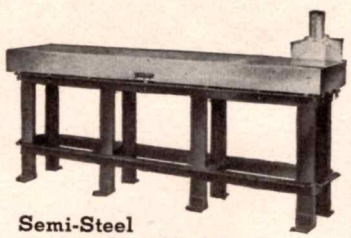


M-4150M2 Actuator

The Air Associates M-4150M2 actuator operates the air shut-off doors on the outboard nacelles of jet bombardment aircraft.

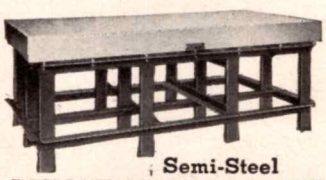
The actuator will withstand a maximum operating load of 6000 lb. in





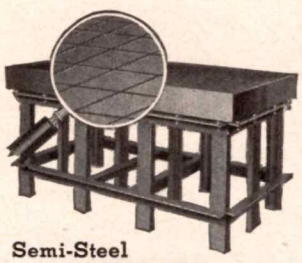
Semi-Steel READING TABLE

for checking propeller blades. Can be scribed or graduated to your specifications. 2 sizes. Stand is equipped with lock-leveling screws.



Semi-Steel LAYOUT SURFACE PLATE

for layout, inspection or assembly lines. Available either precision ground or planer finished. Special leveling screws. Sizes from 12"x18" to 54"x144".



Semi-Steel LAPPING PLATE

Assures perfect fit when lapping metal-to-metal joints on which no sealer is used. Plates have 1/16" grooves ½" apart. Write for bulletin F1759.

770

THE CHALLENGE MACHINERY COMPANY

Office, Factories and Show Room:
GRAND HAVEN, MICHIGAN

Challenge TRADE-MARK ®

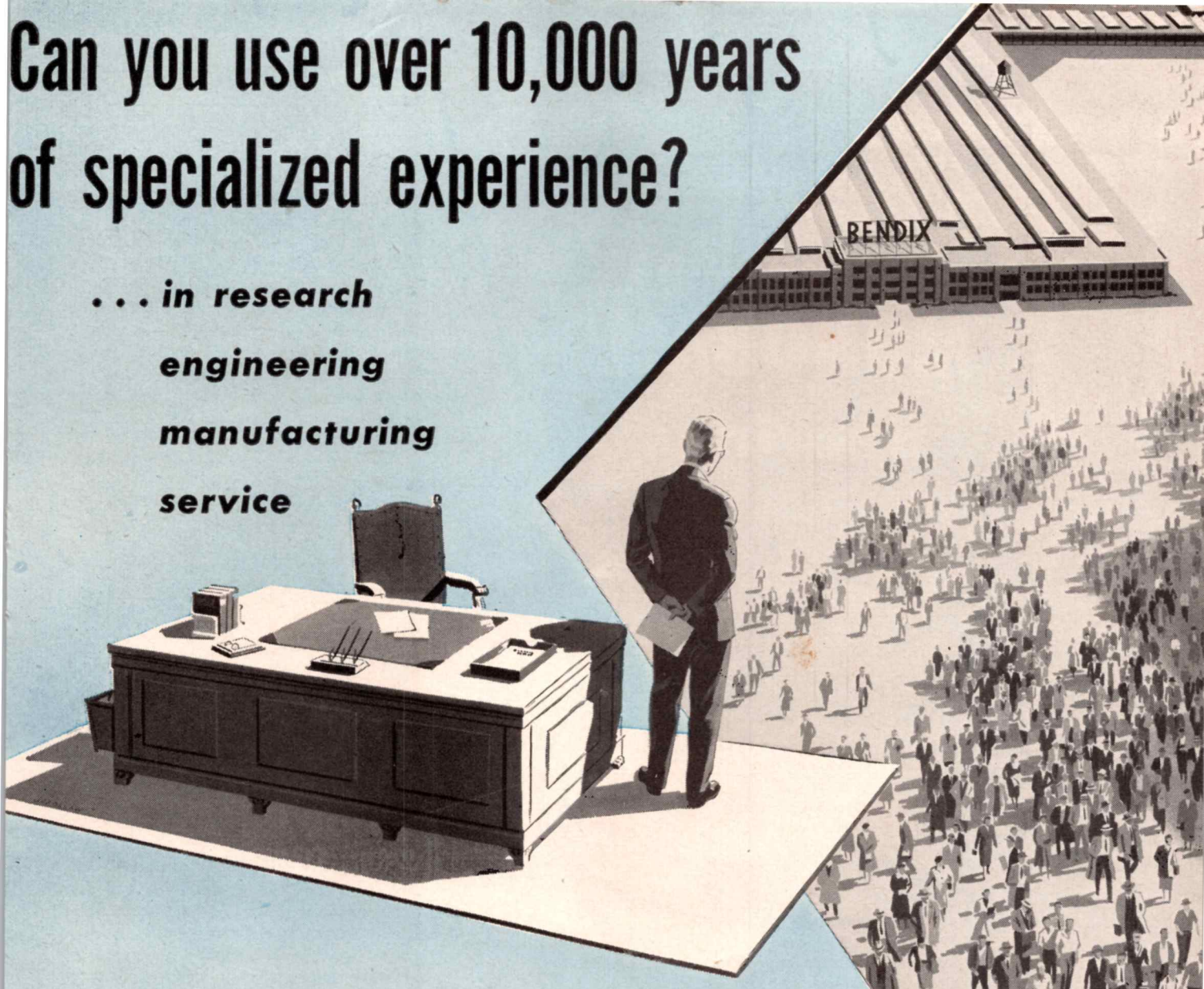
Can you use over 10,000 years of specialized experience?

. . . in research

engineering

manufacturing

service



Bendix Products, South Bend, offers the most comprehensive experience in research, engineering, manufacturing and service, on fuel metering, landing gears, wheels and brakes, to be found anywhere in the industry.

Bring your program problems to Bendix Products, and you have immediately, literally thousands of years of specialized and technical experience at your command —experience on all types of aircraft under all types of operating conditions.

Bendix Products' application of experience to your program starts with a research organization which for more than thirty years has concerned itself with anticipating tomorrow's needs.

Bendix Products engineering likewise is based on unmatched know-how rather than on trial and error methods. Bendix manufacturing facilities have constantly been and are still being expanded for more efficient operation, stepping up production, thereby lowering cost to customers.

Last but not least, an efficient, world-wide Service Organization for all Bendix products is supervised by and from Bendix Products, South Bend, to assure the full performance originally built into all products.

Why don't you put this specialized and technical experience to work on your specific planning programs, whenever fuel metering, landing gear, wheels and brakes are requirements.

BENDIX PRODUCTS DIVISION SOUTH BEND *Bendix* AVIATION CORPORATION

Export Sales: Bendix International Division
205 East 42nd Street, New York 17, N. Y.

Bendix Products Division

Past performance is the best assurance of future achievement!

On practically every new and improved aircraft design, from the earliest models to the present DC-7, Bendix specialized experience has played an important part in setting new performance records. For example, the Bendix Direct Fuel System contributes materially to the accomplishment of faster schedules at lower operating costs in the new DC-7, the latest and greatest Douglas achievement.

Save up to 40% With Replaceable Self-Aligning "MONOBALL"® Bearings

At overhaul time, don't throw away entire rod end bearings. *Save the rod end housings* and replace only the bearings. You can do this with MONOBALL® Spherical Self-aligning Bearings and save as much as 40%. No special tools required . . . use any arbor to take out bearing, then re-stake new bearing.

For long service life and assurance of getting the right bearing for your service requirements, insist on MONOBALL® Spherical Self-Aligning Bearings.

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Molly Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Molly Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Plain types in bore sizes 3/16" to 6". Rod end types in sizes 3/16" to 1½". Our engineers welcome an opportunity of prescribing a type or types which will best serve you. Special types designed to suit individual specifications.

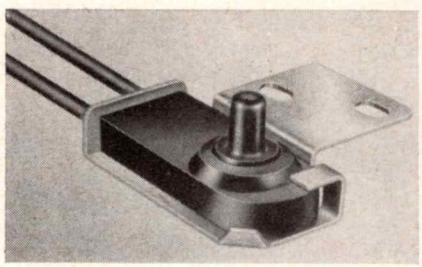
Send now for Engineering Manual describing complete line.

Send now for Engineering Manual describing complete line.
Please address Dept. AD-54

SOUTHWEST PRODUCTS CO.
1705 SO. MOUNTAIN AVE., DUARTE (LOS ANGELES COUNTY), CALIF.

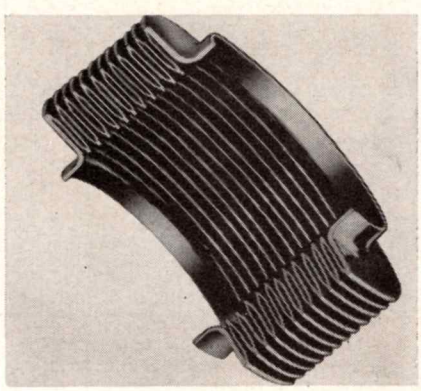
compression when retracted, and a maximum of 4500 lb. in tension when extended. In addition, it is designed to absorb an operating side load of 350 lb. applied perpendicularly to the screw axis at its outer end, and at any point along the stroke. It will withstand static loads that are 150 percent of maximum operating thrust load and 200 percent of operating side load. These loads may be applied at all ambient temperatures from —65 deg. F. to 200 deg. F.

Accurate intermediate positioning is obtainable at any point within full stroke by means of an electrically operated clutch-brake which provides instant stoppage.



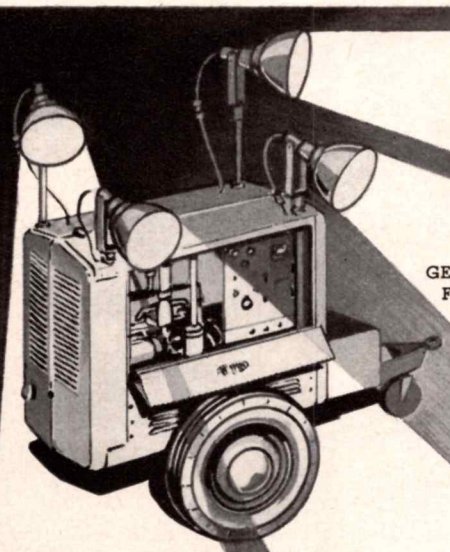
Waterproof Switch

A new style waterproof switch has been announced by Control Products, Inc. Completely encased in vinyl, neoprene or silicone, the new switch has no external mechanism and failures due to corrosion, sticking, breakage or interference with other machinery are eliminated. The small rubber plunger can be fabricated to any desired design. The mounting bracket has no bolts or nuts to corrode and no corners or "pockets" to catch dirt, oil or dust.



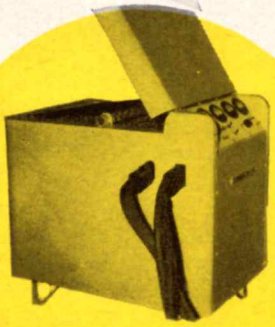
Expansion Bellows

Engineers of Titeflex, Inc., of



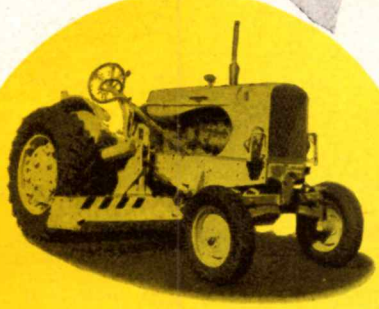
GENERATOR-
FLOODLIGHT SETS

Test stands . . . electric, hydraulic or pneumatic.



Load banks . . . for AC-DC system testing.

name your ground support problem



Magna-Sweep . . . highly maneuverable, self-propelled magnetic sweeper for clearing runways and work areas of magnetic metals.

Self-propelled, multi-purpose, ground-support unit . . . for starting, servicing, testing and towing. Provides A.C., D.C., hydraulic and pneumatic power.

Getting planes into the air and maintaining them calls for a wide variety of ground-support equipment. Consolidated's reputation is built on proven ability to meet any conceivable ground-support problem. The units shown here are typical and now serving U. S. Military Forces.

Consolidated has the knowledge and ability to produce ground-support units to meet specific power requirements in any combination. Write Consolidated about your ground-support problems.

CONSOLIDATED
diesel electric CORPORATION
AIRCRAFT EQUIPMENT DIVISION
STAMFORD · CONNECTICUT

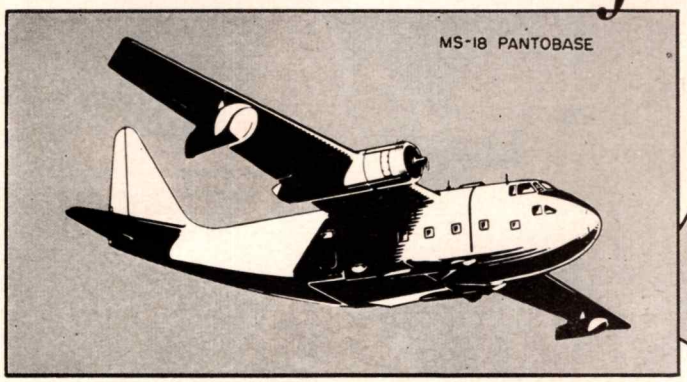
OFFICES IN

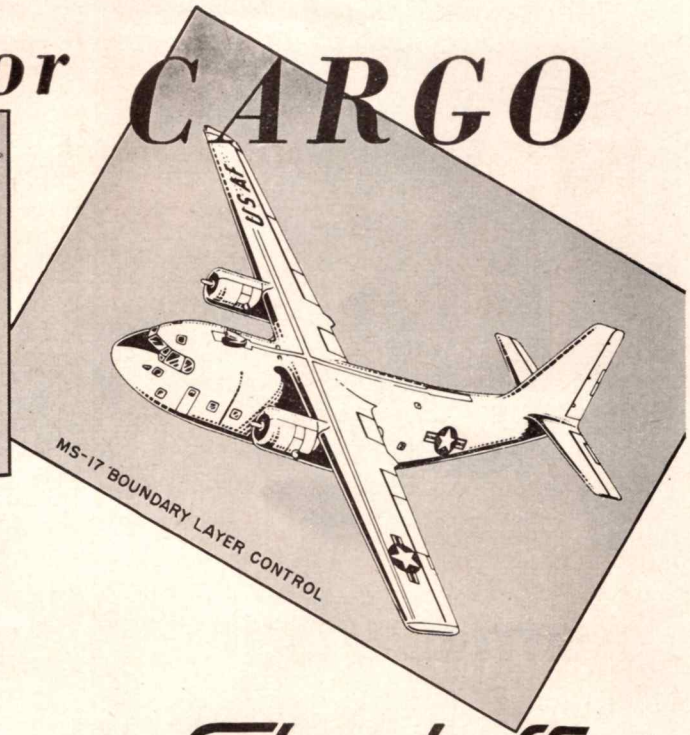
DAYTON, OHIO
TALBOT BUILDING

SANTA ANA, CALIFORNIA
SPURGEON BUILDING

WASHINGTON, D. C.
CAFRITZ BUILDING

DESIGNED for CARGO





With fourteen years of successful Aircraft Engineering Research and Development to his credit—Michael Stroukoff presents the MS-17, with Boundary Layer Control and the MS-18 Pantobase (all bases), Cargo Assault Transports. These new prototypes will be flown by Stroukoff within a few months. They incorporate improvements which have radically reduced take-off and landing distances and permit them to operate from land, snow, water, ice and from fields smaller than any previously required by other aircraft of its size and type.

Stroukoff, keeping foremost in mind the needs of our Military Air Arms and desiring to faithfully serve the USAF has developed and produced these two new Avitrucs to augment the ever increasing strength of the Military Services for Defense.

Stroukoff
Aircraft Corporation
WEST TRENTON NEW JERSEY

GORN

electronic connectors

Miniature Multiples
Rapid Disconnects
Pressurized High Voltage
Printed Circuit Connectors

aircraft controls

Absolute, Differential and Gauge Type Pressure Switches
Liquid Level Switches and Controls
Fuel and Hydraulic System Components

Gorn
STAMFORD ELECTRIC CO. CONNECTICUT
EST. 1929

AVIATION EQUIPMENT

Newark, N. J., have been studying the causes of failure of conventional, convoluted metal expansion joints and found that failure was due mainly to work-hardening which resulted from the reverse bending that takes place at each convolution when the bellows expand and contract. They therefore devised a new expansion bellows construction in which a series of convoluted diaphragms are welded together into a unit which can be expanded and contracted. In this new construction, Titeflex engineers point out, the diaphragms flex in the manner of a cantilever spring. The welded diaphragm joint, being an anchor point, does not move as the bellows flex. Thus it is not subject to the work-hardening caused by reverse bending. To meet a variety of industrial applications, Titeflex engineers evolved two types of bellows using this new construction. The "standard" type, consisting of a series of male expansion elements and the nesting type, comprising a series of nesting male-and-female expansion elements for extreme flexibility applications. The nesting type, made of a series of contoured internesting diaphragms welded on the inner and outer circumferential edges, results in an extremely flexible bellows especially suited for air and steam lines having low internal pressures. Moreover, the nesting construction permits extreme lineal movement, for the nesting bellows can be compressed to solid metal height or expanded to five times the compressed length.

New Harvey aluminum alloy 66S will reduce your costs

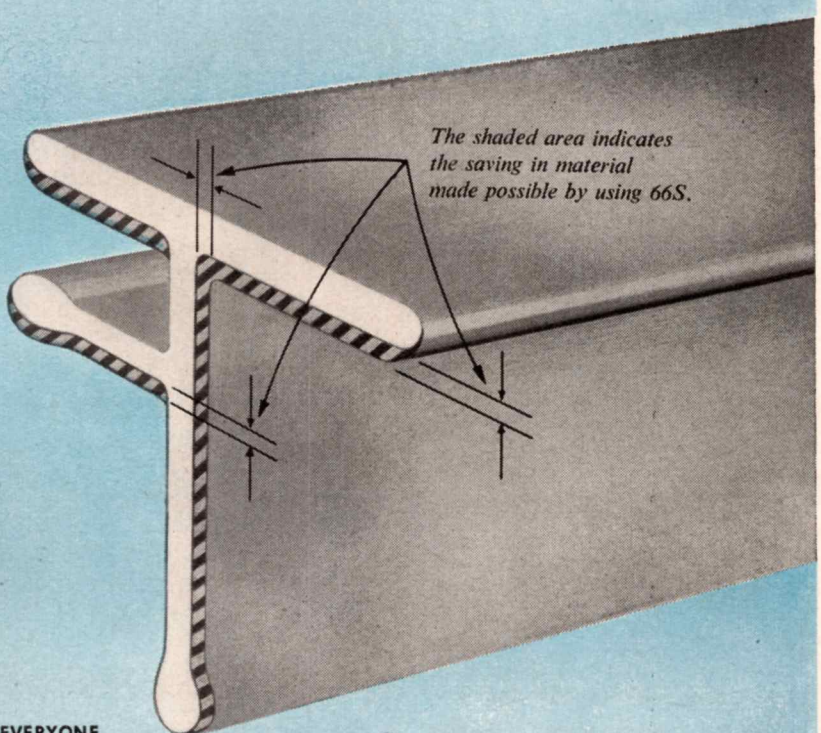
high-strength-low-cost-ratio

means that Harvey metallurgists have combined the essential qualities of many ideal structural alloys into a single new aluminum alloy–66S. This general purpose alloy is bringing real economy to many industries. It combines the high strength of 24S and the good corrosion resistance, weldability and economy of 61S.

Alert aluminum fabricators can now use 66S to reduce material costs, cut weight without sacrificing strength, and lower fabricating costs. You can reduce your costs at Harvey Aluminum . . . tooling service charges are nominal, and Harvey prepays the freight to your dock. Send for your Bulletin on 66S today.

here's how you save

The high yield strength of 66S permits you to reduce the cross section of structural members. This means real dollar savings in material costs. The extrusion below was made of 61S. By using the high yield strength of 66S its cross section is reduced as shown. The saving in material amounts to approximately 26%. Saving in cost, 21%.



MAKING THE MOST OF ALUMINUM—FOR EVERYONE

HARVEY Aluminum

HARVEY ALUMINUM SALES, INC.
TORRANCE—LOS ANGELES, CALIFORNIA
BRANCH OFFICES IN PRINCIPAL CITIES

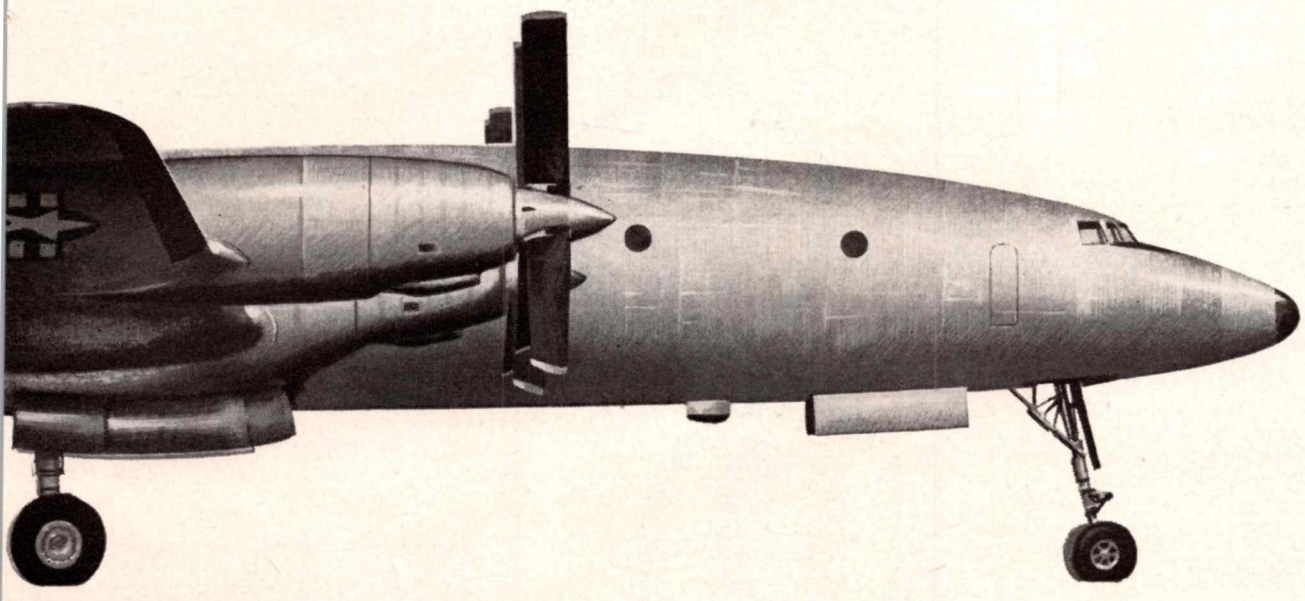
The men at Harvey Aluminum are dedicated to the idea of improving your product while reducing your costs. And remember, we prepay the freight to your plant.

An independent producer of aluminum extrusions in all alloys and all sizes; special extrusions, press forgings, bar stock, forging stock, tubes, impact extrusions, aluminum screw machine products and related products.

Now Flying !

LEADERSHIP DEMANDS CONSTANT ACHIEVEMENT

World's Fastest Propeller-Driven Airliner



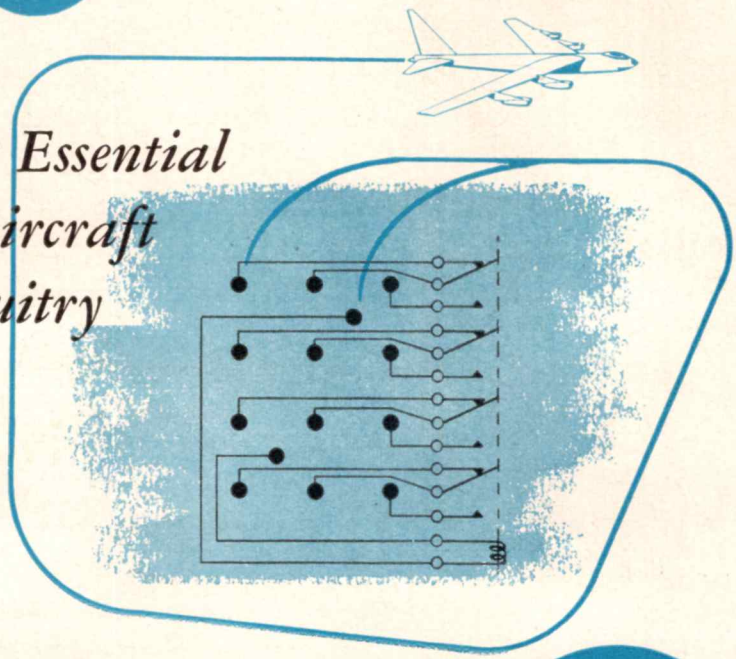
Lockheed's Turbo-prop Super Constellation

Nearly 100 miles an hour faster than any propeller airliner now in service. This powerful new Super Constellation, equipped with American-designed and built Pratt & Whitney T-34 turbo-propeller engines, is now flying for the U. S. Navy. Its tests promise new speed, new performance, and greater economy potentials in the transport aircraft field. This new transport, Model 1249, is another example of Lockheed transport leadership. Watch for important news about this turbo-prop Super Constellation.

Lockheed *Aircraft Corporation, Burbank, California, and Marietta, Georgia*

LOOK TO LOCKHEED FOR LEADERSHIP

COMPLETE RELIABILITY...

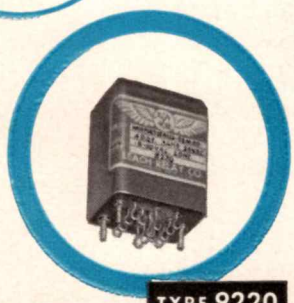


First Essential in Aircraft Circuitry

NEW *Leach* Hermetically sealed Miniature Type DC Relays designed and produced to meet exacting aircraft specifications.

Solder terminal types with two or three mounting studs. Enclosures are hermetically sealed for immunity to climatic or environmental conditions. They are rugged, compact, lightweight.

Leach is always a step ahead in Aircraft Relay research and development. New, improved production techniques and quality control, are your further assurance that *Leach* Relays will give you complete reliability and maximum performance, the *First Essential in Aircraft Circuitry.*



TYPE 9220

TYPE 9220 ES

CHARACTERISTICS

CONTACTS:	4PDT
RATING:	3 Amps. @ 25 VDC, 4 Form C.
COIL:	18-30 VDC, continuous duty, 250 Ohms.
TEMP. RANGE:	−65°C to +85°C. (Also available +125°C on request).
WEIGHT:	4 ozs. approx.

Designed to meet requirements of spec. MIL-R-5757B. Vibration test per spec. MIL-E-5275A, Procedure 1.

COMPARE PERFORMANCE

SWITCH TO *LEACH*

Write for new 44 page 2-color loose leaf Catalog. Illustrates and gives full details of complete line.

SPECIALISTS IN ELECTRONICS AND ELECTRO-MECHANICS

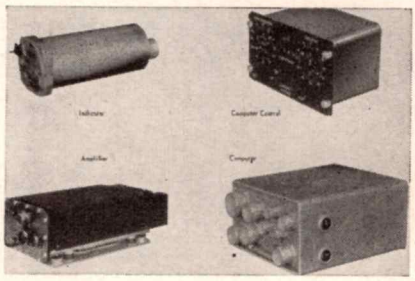
LEACH RELAY CO.

DIVISION OF *Leach* CORPORATION

Representatives in Principal Cities of U.S. and Canada

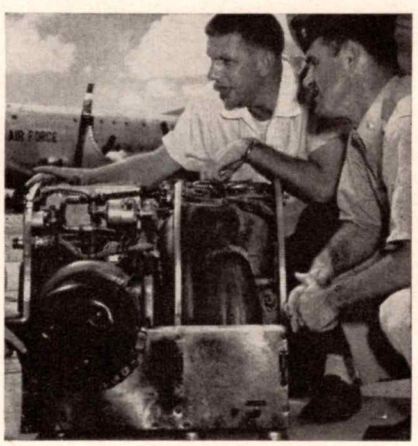
5915 AVALON BOULEVARD, LOS ANGELES 3, CALIFORNIA

AVIATION EQUIPMENT



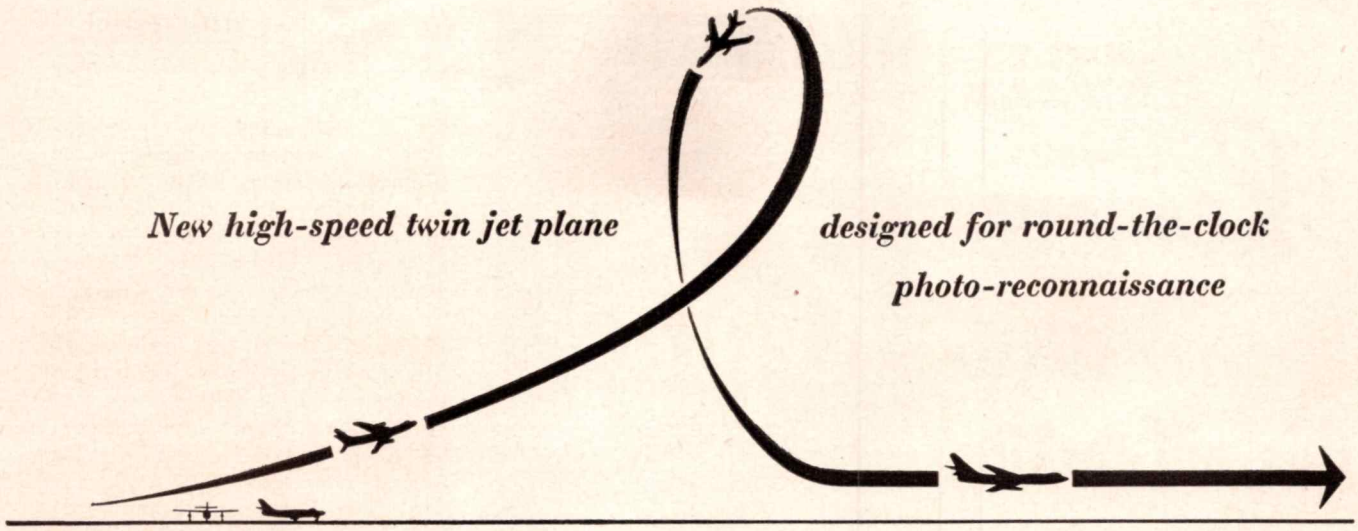
Computer Set

Ford Instrument Co., division of the Sperry Corp., has developed a complete aircraft instrument displaying to the pilot his latitude and longitude without any air-to-ground or ground-to-air communication. Known as the "Computer Set, Latitude and Longitude AN/ASN-6," the unit was developed under Air Force contract. It weighs 45 lb. yet occupies only one and one-half cu. ft. of space. The complete instrument system includes an Indicator, Computer Control, Computer and Amplifier. The pilot sets the wind speed, direction and magnetic variation on the dials and inserts his takeoff latitude and longitude into the Indicator. The Computer obtains airspeed and magnetic heading from the standard airspeed indicator and airplane compass. Once airborne, the instrument set continuously calculates and the Indicator continuously displays the airplane's latitude and longitude.



Gas Turbine Power Unit

Solar Aircraft Co. reveals that one of their gas turbine auxiliary power units installed in a Douglas C-124C *Globemaster* transport has reached 500 hr. of service without overhaul. The unit, driven by a Solar "Mars" gas turbine engine of 50 hp, is used in the



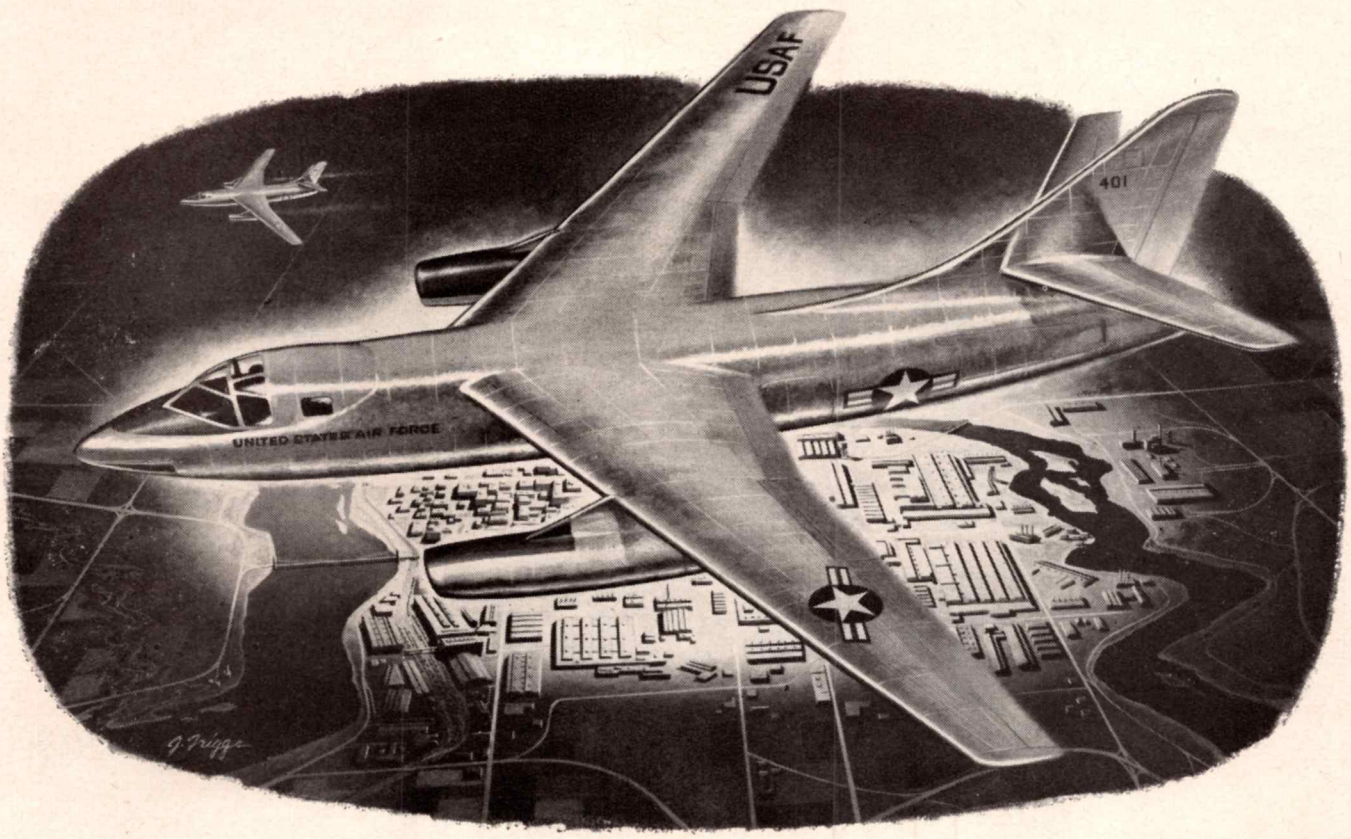
New high-speed twin jet plane *designed for round-the-clock photo-reconnaissance*

—the Douglas RB-66

Now in production for the U. S. Air Force, the Douglas RB-66 will be one of the most versatile photo-reconnaissance planes ever designed.

Complete performance data is still restricted, but this much can now be told. Powered by twin jets, slung in pods from its sharply swept wings, RB-66 will fly in the 600- to 700-mile-per-hour class. Range will permit deep penetration for all-weather, around-the-clock photo-reconnaissance or mapping. Photographic equipment will be of the most modern to collect detailed information by day or night.

Development of RB-66 is another example of Douglas leadership in aviation. Planes that can be produced in volume to fly *faster and farther with a bigger payload* are a basic rule of Douglas design.



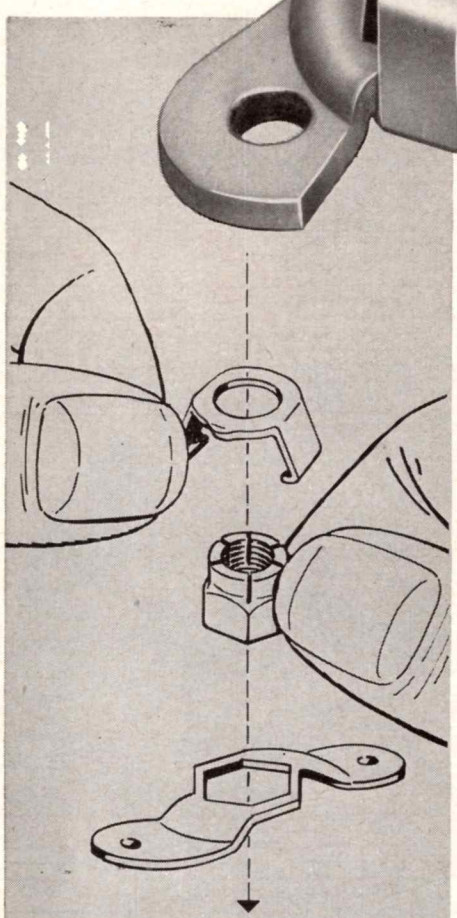
Enlist to fly in the U. S. Air Force

Depend on *DOUGLAS* **First in Aviation**

YOU CAN

Remove and Replace

this self-locking anchor nut



When the removable nut in the NS-109 series is used, installation of anchor base on sub assemblies can be made before chemical cleaning, painting or other surface finishing. Since the threaded locking element can be inserted later, it cannot be damaged or corroded by finishes. The removable nut design also permits easy replacement of the threaded locking element if it should be damaged in service, or if repeated removals make replacement desirable.

NS-109 removable self-locking anchor nut. Meets all envelope dimensions of ANA Standards AN366 and AN362.
WEIGHT: comparable to AN366 and AN362 anchor type nuts.
MEETS: applicable requirements of Spec. AN-N-5 and known requirements of proposed MIL specification on self-locking anchor nuts for torque-out and push-off.
FLOATS: approximately .005 for installation alignment.
SIZES: Available in 8-32, 10-32 and ¼-28 thread sizes.

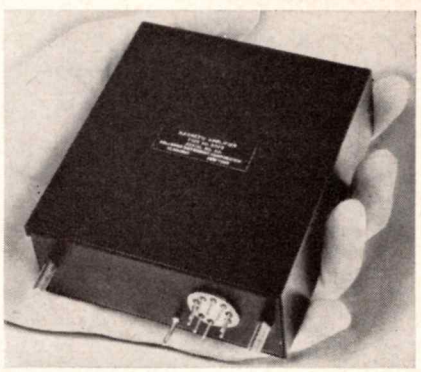
Nutt-Shel

Manufacturers of self locking anchor nuts and special fasteners

811 AIRWAY, GLENDALE 1, CALIF.
Telephones: Citrus 4-2191 • CHapman 5-3693

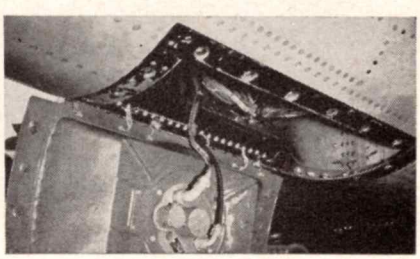
C-123C as a standby source of power for many operations when the main aircraft engines are not running and as an emergency power source during taxiing, takeoff and landing. The entire unit weighs less than 100 lb. and is smaller than a two-ft. cube.

Lockheed Aircraft has ordered $1 million worth of Solar gas turbine units for use in the military transport vertion of the Super Constellation. The "Mars" units are used to provide electrical power for operation of cargo hoists, cargo doors and other accessories, or whenever the main engine-driven generators are providing insufficient power.



Magnetic Amplifier

A compact and lightweight magnetic amplifier is now in production by Kollsman Instrument Corp. The amplifier is contained in an hermatically-sealed case measuring 1.325 in. x 3.5 in. x 3.875 in. and weighs only 15.5 oz. Consisting of two stages of vacuum tube preamplification and a magnetic power output stage, the amplifier operates from a 115-v, 400-cycle source and requires approx. 14 volt-amps at a power factor of 0.7. Input impedence is 5000 ohms and the maximum time delay is 1/400 sec.



Flush ADF

Lear, Inc., has completed initial installation of an ADF-14B automatic

We make them All!

We have the specialized skill, experience and equipment to manufacture special bolts and fasteners to your most exacting specifications.

VOI-SHAN

MANUFACTURING COMPANY, INC.

Serving the Aircraft, Automotive, Marine, Rail, and Oil Tool Industries

8463 HIGUERA STREET • CULVER CITY, CALIFORNIA

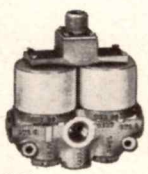
#23271
3-WAY SOLENOID OPERATED VALVE
3/8" Line size
Weight 0.9 lb.

ADEL

Pneumatic control valves set new performance standards!

#23314
CHECK VALVE
1/4" & 3/8" Line sizes
Weight 0.13 lb.

#27370
SHUTTLE VALVE
1/4" Line size
Weight .290 lb.



#27800
4-WAY SOLENOID OPERATED VALVE
3/8" Line size
Weight 1.80 lb.

ADEL designed and manufactured to provide the best in control equipment where pneumatic systems are specified. Safe, dependable operation is assured with instantaneous reaction at working pressures up to 3000 psi. These production units have been thoroughly tested and are qualified to meet all applicable specifications.

ADEL produces a complete line of AIRCRAFT HYDRAULIC & PNEUMATIC CONTROL EQUIPMENT; HEATER, ANTI-ICING & FUEL SYSTEM EQUIPMENT; ENGINE ACCESSORIES AND LINE SUPPORTS.

For complete engineering specifications and counsel

Address: ADEL DIVISION, GENERAL METALS CORPORATION
10773 Van Owen Street, Burbank, California

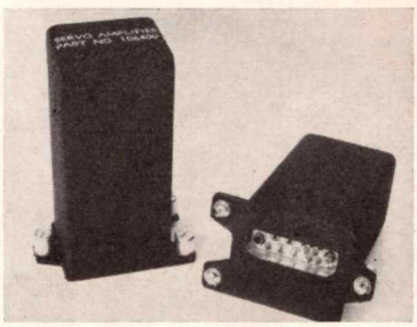
ADEL LEADER IN HYDRAULICS AND PNEUMATICS

MANUFACTURERS OF AIRCRAFT CONTROL EQUIPMENT

DIVISION OF GENERAL METALS CORPORATION • BURBANK, CALIF. • HUNTINGTON, W. VA.

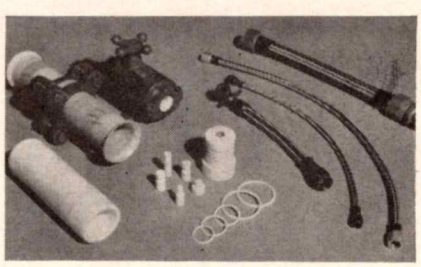
CANADIAN REP.: RAILWAY & POWER ENGINEERING CORPORATION, LIMITED

direction finder in a flush mounting in a Navy McDonnell F2H-4 carrier fighter. The installation consists of a flush-mounted 12-in. Lear Ferro-dynamic Loop in the belly of the airplane. The loop is mounted on the inside of a Lear-built Fibreglas plastic hinged door, replacing a standard metal access door. Lear believes that the ADF-14B system weighs and costs less than one-half previously-used systems yet has about twice the range and higher sensitivity.



Miniaturized Servo Amplifier

A new miniaturized servo amplifier which eliminates the need for an external d-c source has been announced by Servomechanisms, Inc. The amplifier is a plug-in hermatically-sealed type and is designed to control its companion 400-cycle, two-phase servo motor requiring two watts electrical input to the control phase. Servomechanisms also offers a damped control motor as a companion piece for the amplifier to eliminate tachometer cogging or static error and gives servo loop stability essentially insensitive to line frequency. The two units function as a unified controller assembly for any precision servomechanism application.



Plastic Hose

A new plastic hose made from fluorocarbon resins and capable of

when is an airplane great?

...When its performance characteristics solve critical operational needs.

...When its versatility permits a wide range of functions.

...When a strong growth potential is inherent in its basic design.

...When it is a "pilot's airplane", essentially simple and easy to fly.

....And finally when it's out of engineering and in the air—when it's being delivered and in operation.

The Martin B-57—brilliant new member of the Air Force's family—is in truth a great airplane. Low wing loading gives it take off and high altitude performance characteristics exceptional in the reconnaissance bomber class, and the Martin rotary bomb door makes it capable of both high and low-level bombing runs at fighter speed.

Basic configuration changes now make possible adaptions of the USAF B-57 to cover a wide variety of critical missions.

But for the final word on this remarkably versatile airplane—ask the man who has flown one.

You will hear more about Martin!

MARTIN

BALTIMORE · MARYLAND

RR

Get the message through!

Our national defense no longer depends on a single horseman riding through the night to spread the alarm . . . But the Paul Revere spirit remains the same. The network of communications that helps protect our country is vast, but its operation is dependent on each individual component and the company that stands behind it.

Since 1922 Radio Receptor Company engineers have pioneered in radar, navigation and communications equipment—Always searching for new and better ways electronically to serve the nation's interests. One of the products we are delivering now is the Germanium Transistor, available at last for practical use. Tiny and with great potential, it represents one more step in the advance of communications.

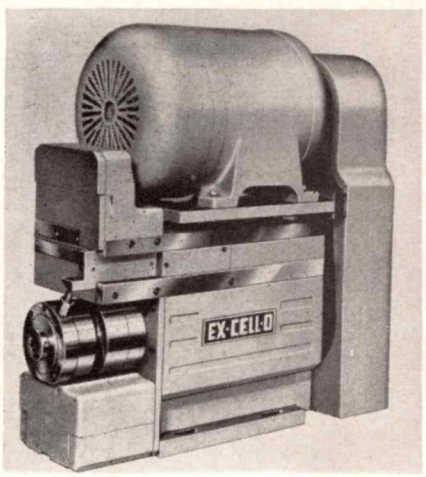
We at Radio Receptor Company are proud of our work with the Armed Forces in the manufacture of communications equipment. Our goal is ever increasing efficiency and reliability.

RR

COMMUNICATIONS • RADAR • NAVIGATION
THERMATRON DIELECTRIC EQUIPMENT
GERMANIUM DIODES AND TRANSISTORS
SELETRON SELENIUM RECTIFIERS

RADIO RECEPTOR COMPANY, INC.
In Radio and Electronics Since 1922
240 WYTHE AVENUE, BROOKLYN 11, N. Y.

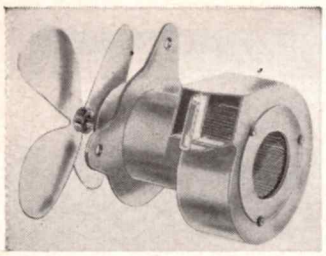
handling the newly developed synthetic oils used in the latest design jet engines has been announced by Resistoflex Corporation. Belleville, N. J., manufacturers of industrial hose assemblies and elastomeric products. A series of exhaustive tests have demonstrated the ability of the new hose to handle the new lubricating oils under the severe operating conditions of modern jet engines. Development of the synthetic lubricants has created a materials handling problem of its own. Conventional fluid-carrying materials are not able to stand up under the high temperatures reached by the lubricants. Another factor is the effect of corrosion. In order to achieve efficient use of the new synthetic oils, a material was needed with the necessary physical and chemical properties. Heretofore, frequent replacement of conventional materials impeded the efficient use of the new lubricants. Resistoflex's fluorocarbon hose will eliminate this problem.



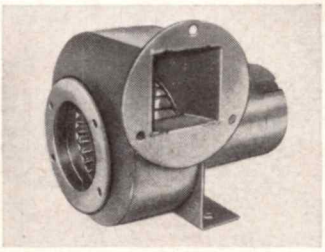
Power Unit

A quill type hydraulic power unit for actuating tools in special machines has been introduced by Ex-Cell-O Corp. The new unit has a 3 hp capacity and an 8 in. stroke. The new model is self-contained, hydraulically operated, and designed for single tools or multiple spindle heads for such operations as drilling, reaming, counterboring and spot facing.

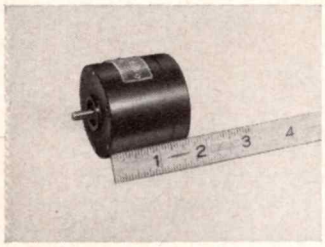
The unit cycle may be initiated electrically or manually. The cycle may include rapid approach, first and second feeds, reverse, rapid return and stop. The lengths of rapid approach and feed movements, the reverse and stop positions are controlled by ad-



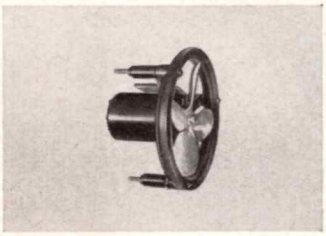
A15ABF-1 115 Volt — 400 cycle. Blower delivering 50 CFM at 8500 RPM. Propeller fan delivering approx. 300 CFM at 8500 RPM.



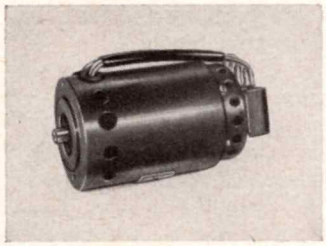
B20B3—115 Volt 400 cycle single phase centrifugal blower. Delivering 140 CFM of air against 2" of water operating at 6500 RPM minimum.



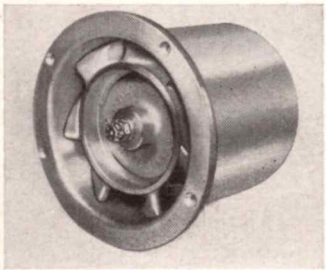
A08C1—2 phase control motor for operation on 60 cycle supply 115 Volt on one phase and 40 Volt on control phase. 3.0 oz/in starting torque on above voltages. 1500 RPM. No load speed.



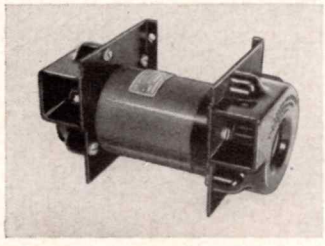
A15AD3—Axial blower unit for operation on 115 Volt 60 cycle single phase supply at 3300 RPM delivering 35 CFM at 0.2 S.P. This unit has special mounting bracket.



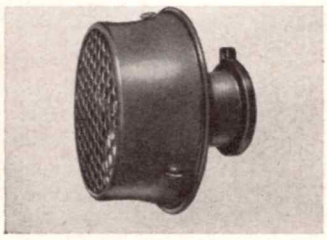
A15HF—115 Volt 60 cycle single phase capacity start & run sychronous motor running at 3600 RPM. This unit has special terminal block mounted on end of motor.



450C-1—115 Volt 400 cycle phase axial—vane type blower delivering 200 CFM at 6 S.P. Weight approx. 5 lb.



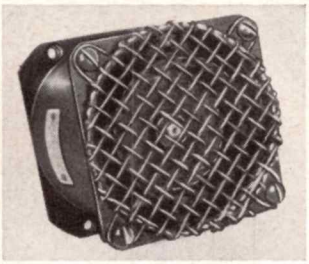
A15BD—115 Volt 400 cycle single phase double blower delivering 26 CFM total at 0 static. This unit has special mounting brackets.



A11A-1—115 Volt 400 cycle single phase propeller type blower using 4" 4 blade fan.

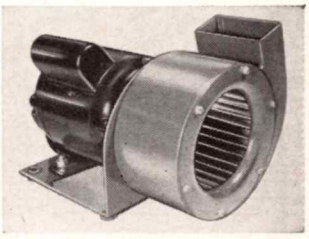
Manufacturers of Specialty Rotating Equipment Including Motors, Fans & Blowers

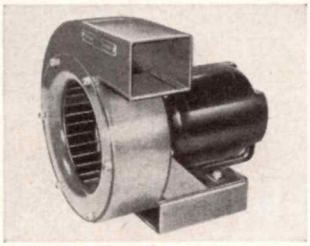
The features of all AIR MARINE motors include Stainless steel thru-bolts, Rigid die-cast aluminum housings, and Riveted stator to insure Extra-Rigid Construction assuring positive bearing alignment and uniform air gap. Motors are protected against humidity and fungus growth—can be mounted in any position—are equipped with ball bearings using lubricants for high and low temperatures—meet all AN specifications.



A11A-2—115 Volt 400 cycle single phase axial vane blower delivering 70 CFM at 1" static pressure at 11,000 RPM.

631 x 35 115 Volt, 60 cycle or 220 Volt, 60 cycle, 1 or 3 phase. 3450 RPM continuous duty. 250 CFM at 2½" water gauge. Used in microwave generators, unattended repeater stations. Fits in space 13½" long, 8¾" wide, 7¾" high.





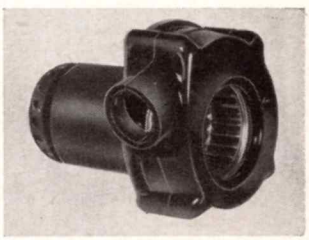
631 x 1—115 Volt, 60 cycle, 3450 RPM 100 CFM @ 2½" water gauge. Fits in space 9½" long, 8¾" wide, 7¾" high.

Variable frequency blower for operation on 115 Volt single phase. Available with axial fan or centrifugal blower.

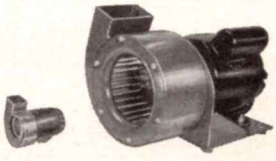
A15BF-15—50 to 800 cycles—single winding available with axial fan or centrifugal blower.

A15AB-2—50-60 cycle and 400 cycle operation single winding.

A15CF10—50-60 and 320-1000 cycle operation dual winding.



Showing comparison between our large and small blowers



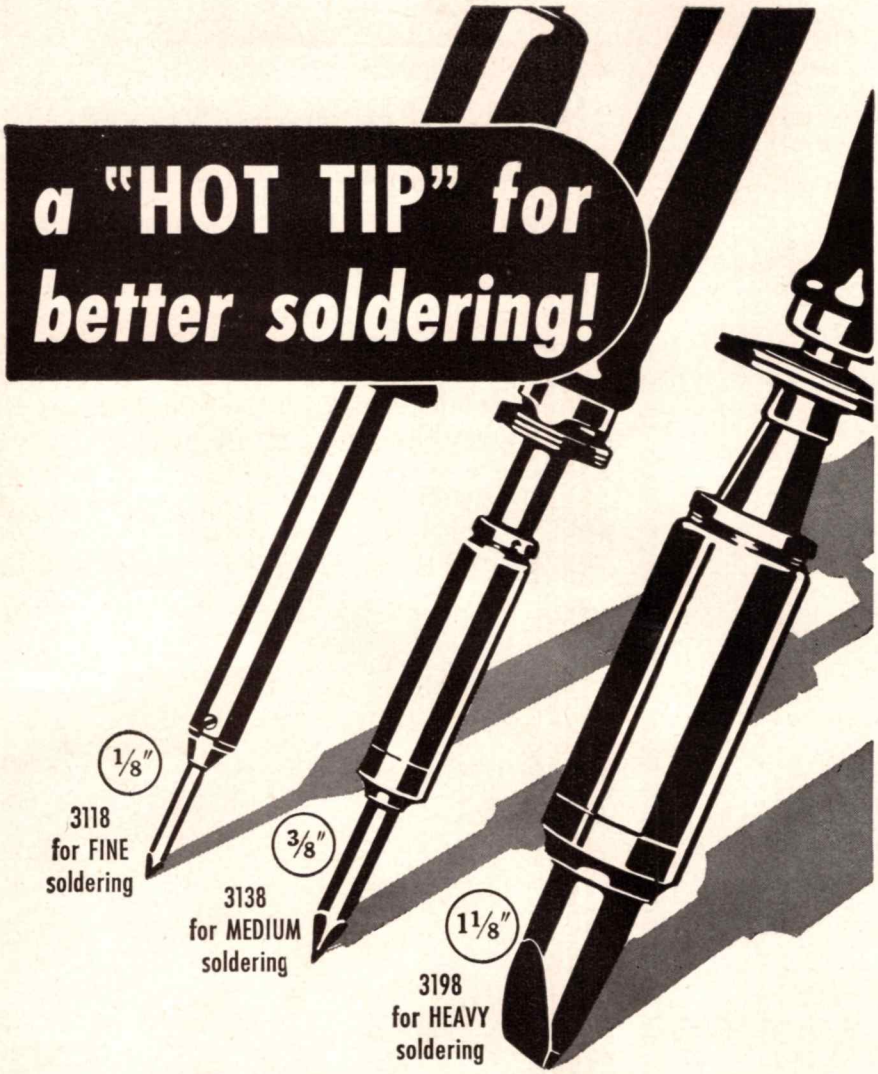
The motors and blowers on this page are representative of the many varied models available. Detailed information specifications and performance data on all the above units available on request.

Constantly developing to meet your exacting needs . . .

air-marine motors Inc

369 Bayview Avenue
Amityville, L. I., N. Y.
AMityville 4-6122

West Coast Factory
2055 Pontius Avenue
Los Angeles 25, Calif.



use **American Beauty**

ELECTRIC SOLDERING IRONS

The Tip . . . That's where American Beauty Electric Soldering Irons "pay off" in economy, dependability, efficiency—on all your soldering jobs.

Made of commercially-pure copper rod, heavily nickeled to resist corrosion and oxidation, there are American Beauty tips in many special shapes and sizes available to fit particular requirements.

All 12 models of American Beauty Electric Soldering Irons feature tip lengths proportioned to size to permit full insertion into the element core and maximum soldering length.

American Beauty Electric Soldering Irons are available in Tip Sizes from 1/8" to 1 1/8" and in wattages from 25 to 550.

Write For Descriptive Literature

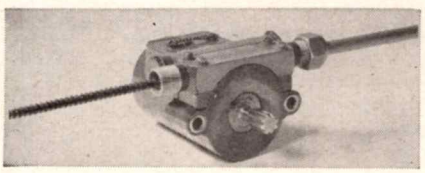
AMERICAN ELECTRICAL HEATER COMPANY

American Beauty ELECTRIC IRONS 60 YEARS YOUNG 1894 1954

No.143-H

DETROIT 2, MICHIGAN

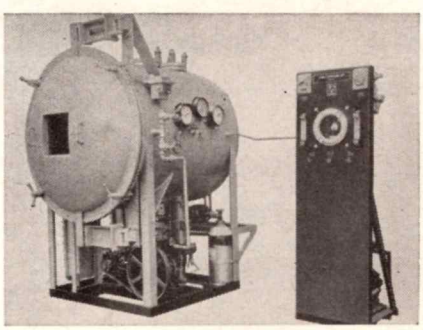
justable dogs. Feeds are adjustable by means of orifice dials protected by a hinged cover. The electrical equipment is enclosed, yet is readily accessible for inspection or service.



Servo Control

Teleflex Inc. has developed a mechanical feed-back linkage for a Westinghouse jet engine control. The control is accurate within one-tenth of one percent in an 8 ft. system with 270 deg. of bend. This accuracy is maintained over a temperature range greater than 300 deg. F. The Teleflex Control Box designed with positive stops establishes an operating range for spring tension, which can be varied to suit each individual engine application.

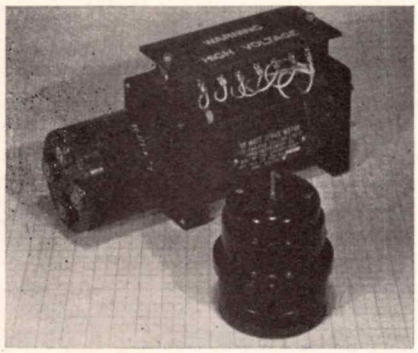
A detachable cable backup is provided for easy assembly between the cable and the box. This permits easy synchronization of control between the two end conditions. The loop in the Teleflex Control System routing can accommodate thermal expansion of several inches in the engine. This permits motion between fixed points with no additional backlash. Total travel of the control exceeds one revolution of the gear box.



Explosion Chamber

Tenney Engineering, Inc., Newark 5, N. J. announces the addition of a new Explosion Chamber to its line of environmental test equipment. The new chamber may be used: (1) to determine the effect of explosions on materials, components, sub-assemblies

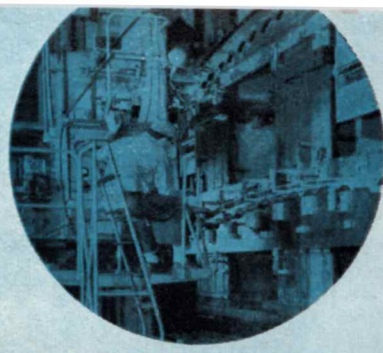
or completed units, or (2) to determine whether equipment will cause explosions when operated in an explosive atmosphere. Comprising a cylindrical shell, equipment to cause an explosion, and control instruments, the chamber can be furnished in a variety of sizes and with any auxiliary equipment desired. Standard size is four ft. in diameter by five ft. long. Since many contemplated uses of the chamber will involve explosions under high altitude conditions, the chamber is equipped with a vacuum pump which will simulate altitudes to 80,000 ft. Additional equipment supplied with the chamber includes two 100 point terminal pads good for 25 amps at 230 v, and two hand turning shafts. These extras enable equipment to be operated within the chamber exactly as it would be in normal use.



Rate Generator

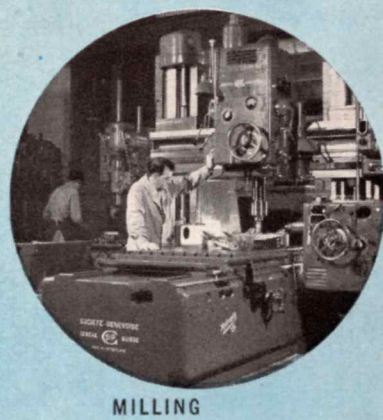
Ford Instrument Co. announces a precision a-c rate generator with a high degree of accuracy in the linear translation of rotational motion into voltage. The new unit incorporates a high-purity copper alloy cylindrical dragcup which serves as the rotating element. It rotates in the air gap between a cylindrical stator and a core, both of precision-machined, laminated, magnetic steel. The instrument functions as a two-phase induction generator. When one stator phase is excited by a constant-frequency, constant-amplitude voltage source, the output voltage from the other state phase has an amplitude proportional to the speed of the dragcup and a frequency identical to that of the excitation voltage. The unit functions as a velocity feedback element in servo systems, in tachometric applications and as a computing element where rate is a direct function. The unit is available in four

MASS PRODUCTION *to* PRECISION TOLERANCES

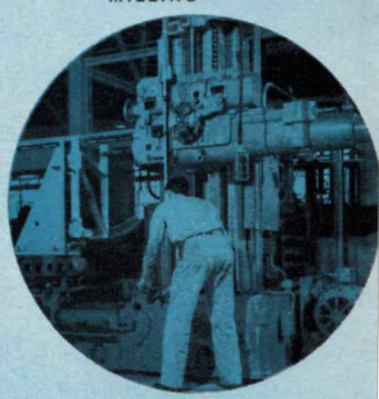


KELLERING

Rapid and accurate production of precision parts depends on fast machines, engineered to produce within close tolerances. Axelson's Los Angeles plant is one of the Pacific Coast's best equipped and most versatile machine shops. A new modern plant at Montebello, California, has expanded facilities. This addition reflects increased contracts for aircraft components resulting from our record of maintaining production schedules at competitive prices.

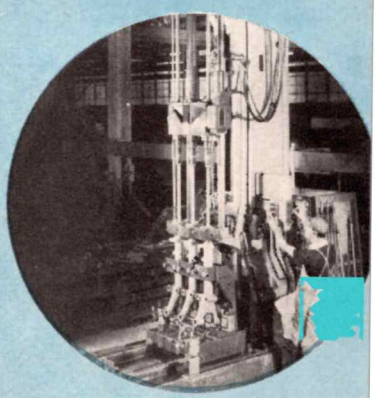


MILLING



BORING

We invite personal inspection of our facilities, but in the meantime, we will be glad to forward Bulletin 5037 which gives you a preview.

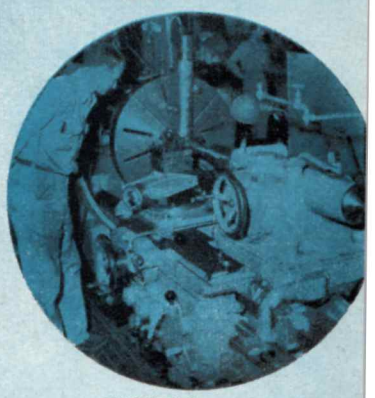


HONING

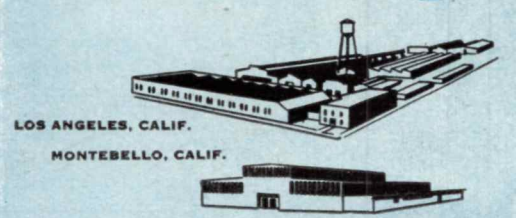
A PARTIAL LIST of Airframe Manufacturers Using Axelson-built Components

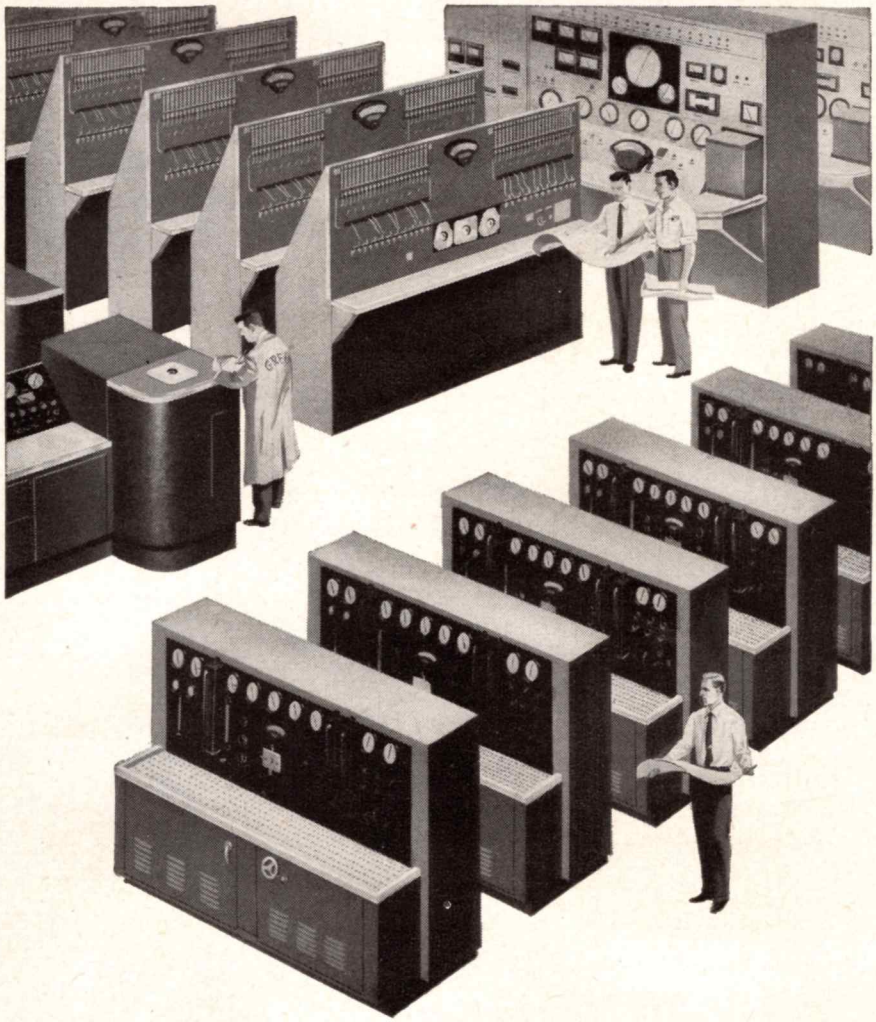
Douglas Aircraft Company
North American Aviation, Inc.
Lockheed Aircraft Corporation
The Glenn L. Martin Company
Boeing Airplane Company

AXELSON
MANUFACTURING COMPANY DIVISION
P. O. Box 58335, Vernon Station, Los Angeles 58
PRESSED STEEL CAR COMPANY, INC. PSC



TURNING





Copied...but never equalled!

GREER
TEST EQUIPMENT

IN THE FIELD of aircraft test equipment, as perhaps in no other, confidence in the maker is all-important. Planes and human lives depend upon the reliability of this vital equipment.

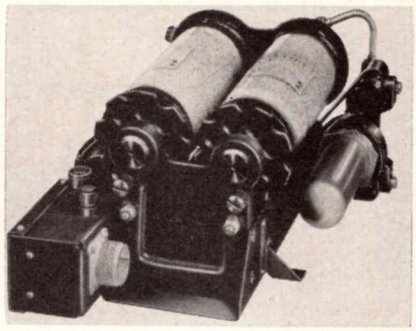
That is why we say, "copied . . . but never equalled." Greer methods of manufacture and inspection are unique. They result in quality control that we believe unequalled in this field. Each part of each machine must pass exhaustive tests before assembly — then the completed equipment is carefully inspected before delivery to customers.

For Greer dependability is not a manufactured component to be drawn to scale and copied. Greer dependability is a result of many years experience of many men, pioneers in this field. It is the reason the most honored names in the aviation industry turn instinctively to Greer to test their products.

We invite you to call on Greer engineers to discuss your testing requirements. Call or write without obligation.

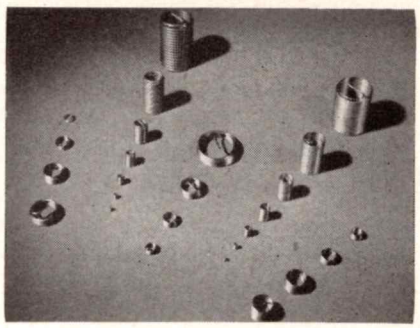
GREER HYDRAULICS INC. • International Airport • JAMAICA 30, NEW YORK
Field offices in Chicago, Dayton and Detroit • Sales Representatives in all principal cities

models for 60-cycle and 400-cycle operation, with or without temperature compensation.



Model RR-10040 Desiccator

The oil-free Lear-Romec air pump draws air through one desiccant jar and discharges it through the other for continuous recirculation of air in the bombsight lens dome. Desiccant jars contain a breather which replenishes with dry air any loss in the otherwise closed circulating system. Replaceable jars of anhydrous $CaSO_4$ "Drierite" are conveniently inserted, when contents of used jar is saturated. Color indicates approximately relative humidity as adsorption progresses. Content turns pink in the presence of moisture laden air absorbed on the granues. Danger line is indicated on the jar. Air from desiccator passes through micronic filter to bombsight. Capacity of the pump is 1200 cu in. per min. air flow. Motor is 1/15 hp, 115 volts, ac, 2 amps, 400 cycle, single phase. A pressure switch closes to light a signal on the junction box to warn the operator when system pressure is low. Switch operates in range of ½ to 3 psi. Replaceable fuse is adjacent to the lamp. Unit weighs 13.94 lb.

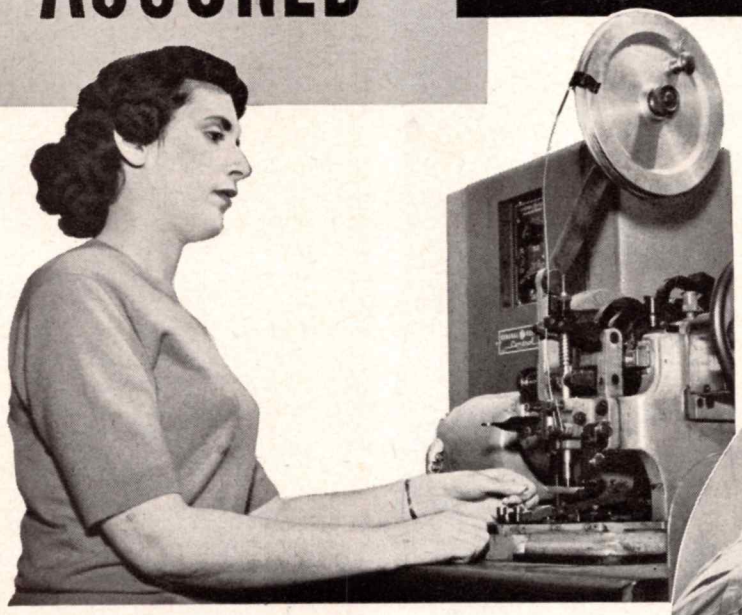


Locking Insert

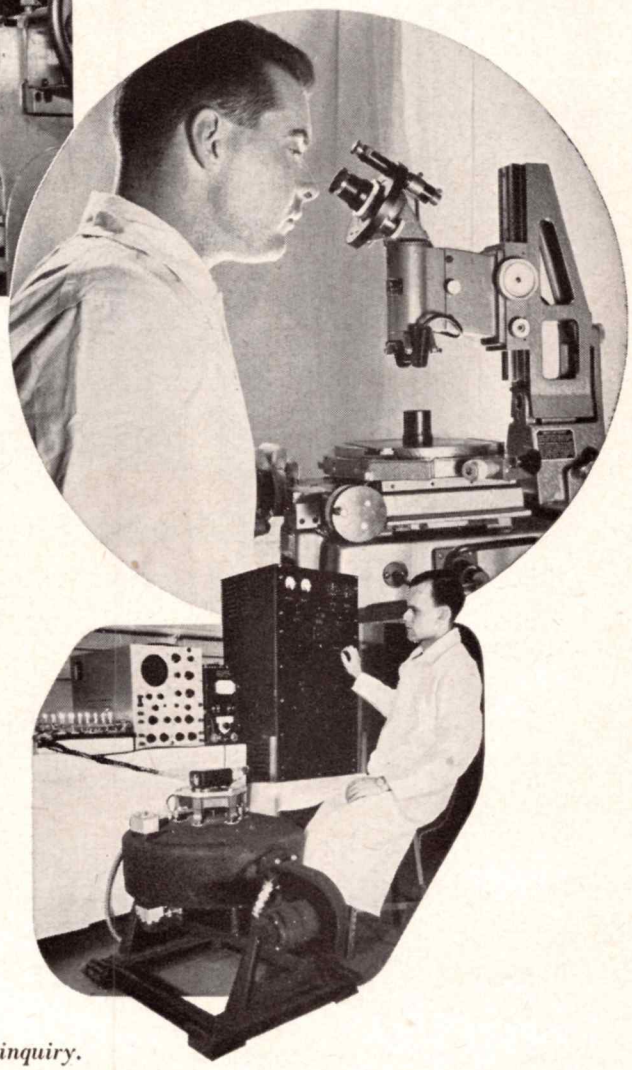
A one-piece screw thread lock fastener insert that performs three impor-

RELIABILITY ASSURED

WITH NEW DIAPHLEX *Sealed Relays*



DIAPHLEX RELAYS ARE NOW PACKAGED AND SEALED WITH THE SAME QUALITY ASSURANCE AS EMPLOYED IN THE PRODUCTION OF INCANDESCENT LAMPS.



This quality assurance is made possible by the use of electronically controlled contact welders, inert materials, highly refined instrumentation for performance measurement, sterile parts assembled in dust-free air-conditioned rooms, advanced quality control techniques and similar advancements in the art of fine instrument manufacture.

Extensive endurance and MIL qualification tests conducted by Inland Testing Laboratories verify the necessity for these extra safeguards.

Satisfactory relay performance under actual field conditions conclusively substantiate the fact that precise manufacture under controlled conditions and electronic inspection methods are essential prior to sealing and inert gas charging and mass spectrometer leak detection.

Furthermore a large portion of Diaphlex relay output is assembled into Cook manufactured "Brain Boxes" and electronic gear which furnishes first-hand experience with relays engineered for the job.

These measured results coupled with the experience of skilled workers who have been trained for the past decade in relay design, tooling, fabrication and assembly "Assure the Reliability" of Diaphlex relays.

We invite your inquiry.

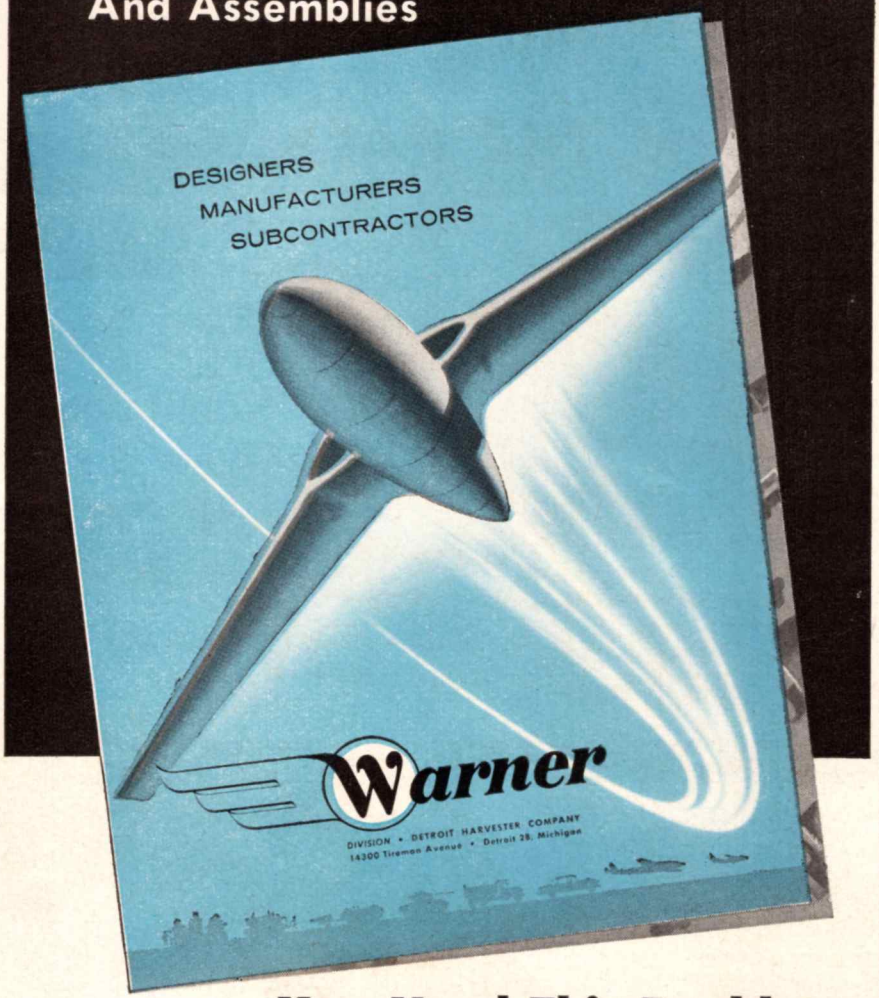
Cook Electric Company

Established 1897

2700 Southport, Chicago 14, Illinois

Diaphlex—Aircraft Components and Accessories • **Wirecom**—Wire Communications, Protection & Distribution Apparatus • **Magnilastic**—Expansion Joints, Heavy Industry Equipment, and Airframe Structures • **Cook Research Laboratories**—8100 Monticello Avenue, Skokie, Illinois • **Inland Testing Laboratories**—1457 Diversey Parkway, Chicago 14, Illinois • **Electronic Systems Division**—2533 N. Ashland Avenue, Chicago 14, Illinois • **Subsidiary: Canadian Diaphlex Limited**—Aircraft Components and Accessories, Toronto, Ontario, Canada • **Plymold Division**—3415 Belmont Avenue, Chicago 18, Illinois.

If You Are Looking For A Precision Subcontractor For Intricate Parts And Assemblies



. . . You Need This Booklet

The Warner Division of Detroit Harvester Co. has moved into a new and larger manufacturing plant. This expansion places Warner in a position to take on additional precision subcontracting work for aircraft and ordnance plants.

Capitalize on Warner's ability to manufacture to exacting tolerances. Consider Warner for the production of—

Landing Gear Cylinders, Pumps, and Valves
Hydraulic and Pneumatic Assemblies
Aircraft Fittings
Machining of Aircraft Forgings

Send today for your copy of the illustrated booklet shown above describing Warner's complete facilities. Warner engineers will welcome the opportunity to discuss your requirements with you.

Warner DIVISION OF DETROIT HARVESTER COMPANY

14300 TIREMAN AVENUE • DETROIT 28, MICHIGAN

DESIGNERS AND MANUFACTURERS OF HYDRAULIC PUMPS • VALVES • ACTUATORS

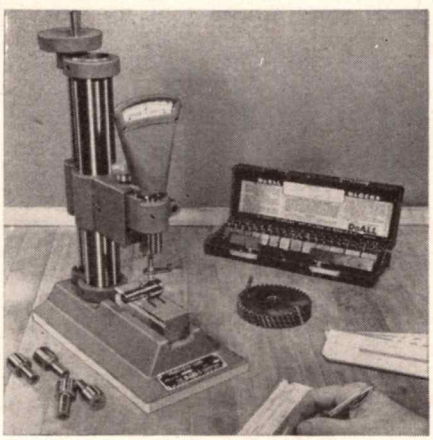
Warner Branch Offices

520 West Ave., Room 212, Norwalk, Connecticut
56 Canterbury Drive, Dayton 9, Ohio
2422 Forest Park Blvd., Fort Worth, Texas
7227 West 90th St., Los Angeles 45, California

tant functions has been developed by Heli-Coil Corp. It automatically locks the screw so that it is vibration-proof, provides a high-strength thread and it automatically locks itself into the parent material without using pins, rings, staking or other devices.

Called a "screw-lock" insert it can be used with an otherwise frozen design because it requires no more boss material or wall thickness than a conventional tapped thread. It is now in successful use by a leading aircraft company for cowl fasteners and is being actively considered by other aircraft manufacturers for airframe assemblies. The insert is made of precision-formed stainless steel wire that seats itself springlike in a hole to provide 60-deg. threads. A constricting area is featured in the bottom coil which grips the screw. The locked screw may readily be freed by applying breakaway torque approximately the same as the torque used in making the original assembly.

The insert is formed of 18-8 stainless steel wire, is dimensionally stable over a wide temperature range and resists wear, corrosion, galling and seizing. It provides strong, permanent threads in soft materials such as aluminum, magnesium, and plastics.



Mechanical Comparator

The DoALL Co.'s Producto-Chek is a lightweight mechanical comparator. A lead screw on the column provides the coarse adjustment and facilitates rapid positioning of the gaging head. There are two fine adjustments. One, a thumb screw type, moves the gaging head slightly up or down; the other is a lever to move the dial scale from left to right for minute zeroing move-

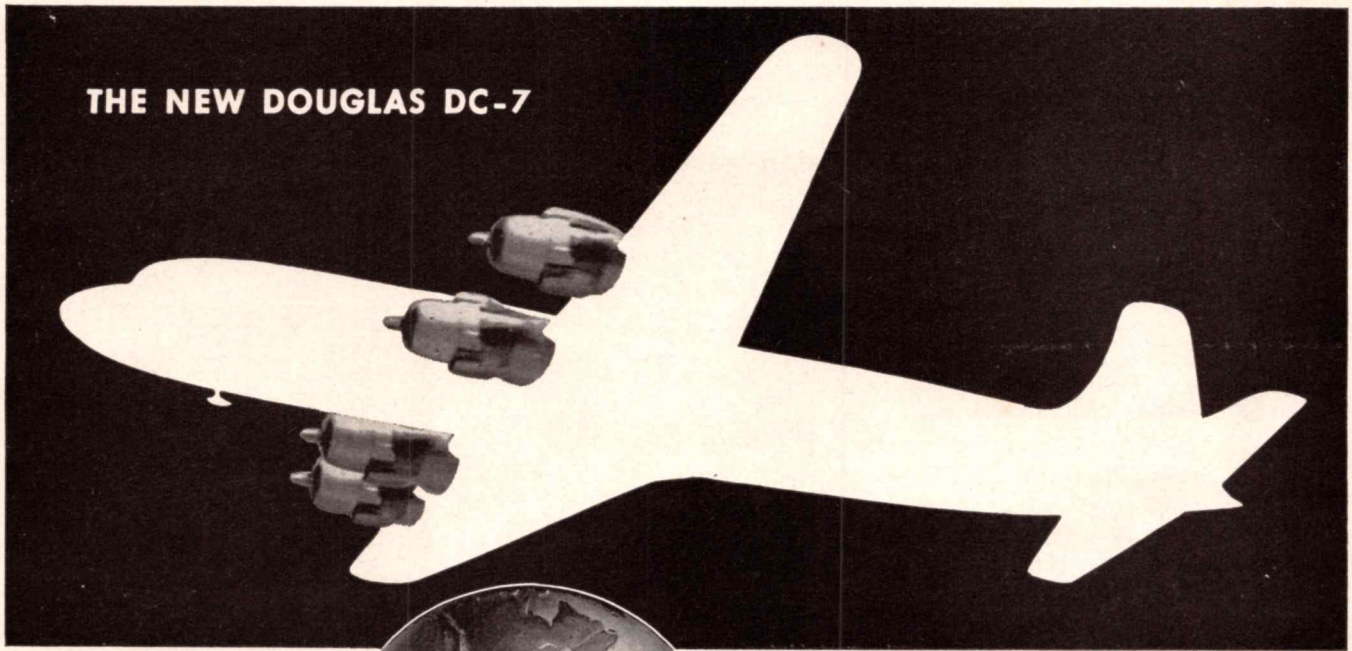
THE PROOF IS IN THE PACKAGES!

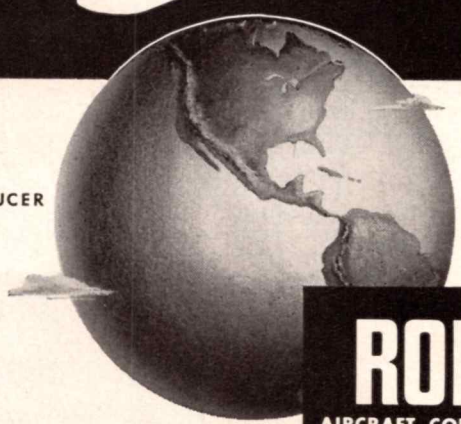
Rohr has won fame for becoming the world's largest producer of ready-to-install power packages for airplanes – like the Lockheed Constellation, Douglas DC-7, the all-jet Boeing B-52 and other great military and commercial planes.

This, we believe, is proof of Rohr's engineering skill and production know-how. But it's not the whole story.

Currently, Rohr Aircraftsmen are producing over 25,000 different parts for aircraft of all kinds... many of these calling for highly specialized skill and specially engineered equipment.

Whenever you want aircraft parts better, faster, cheaper – call on Rohr. The proof of engineering skill and production know-how is in the thousands upon thousands of power packages that have made Rohr famous.





WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES
– RECIPROCATING, TURBO-PROP, TURBO-COMPOUND AND JET.

ROHR
AIRCRAFT CORPORATION

CHULA VISTA AND RIVERSIDE CALIFORNIA

a. FIN TOP RADOME

b. FIN LEADING EDGE

c. FIRE CONTROL RADOME

d. NOSE RADOME

Write for catalogue:
"Hexcel Structural Honeycomb
for Sandwich Structures"

light! strong!

Hexcel®

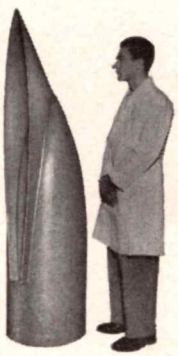
STRUCTURAL HONEYCOMB

GIVES OPTIMUM RADAR TRANSMISSION

These four basic parts of the great new Douglas A3D Skywarrior utilize Hexcel glass fabric-plastic Honeycomb core.

High-strength, light-weight honeycomb structures give excellent microwave transmission for all radomes and provide high structural strength in the fin leading edge.

Hexcel Glass-Fabric Honeycomb may be *pre-curved* to contour to speed layup time, reduce fabricating costs.



Here's a closeup of the top radome, composed of Hexcel Glass Fabric-Plastic Honeycomb in ¼" cell size, faced with glass fabric skins.

HEXCEL PRODUCTS COMPANY

A Division of California Reinforced Plastics Company

955 SIXTY-FIRST STREET, OAKLAND 8, CALIFORNIA

Dept. D

Hexcel Structural Honeycomb in Glass Fabric-Plastic • Aluminum • Cotton Fabric

New AMERICAN Inertia Reel

MULTIDIRECTIONAL SHOULDER HARNESS TAKE-UP

MODEL 20

1. **Lightest reel**—about 1.5 lbs.
2. **Thinnest**—1¼" over-all.
3. **Complies with Specification MIL-R-8236 Type MA-2.**
4. **Lowest in cost** of any multidirectional reel.
5. **Positive** in action. Locks instantly on primary crash impact.
6. **Full 18" harness cable travel,** as called for in Specification.
7. **Ideal for ejection seats.** Locks instantly and automatically when electrical circuit is interrupted during ejection cycle.
8. **Manual control is thinnest ever made,** only ½" thick over-all.
9. **Reel cannot be unlocked by quick retracting movement.**
10. **Can be mounted in almost any position,** as inertia locking action is controlled by a new inertia switch, mounted independently of reel. The light weight switch will operate several reels.
11. **Reel can be disassembled** and overhauled by user without returning to factory for recalibration. Only the trouble-free inertia switch is factory-sealed.
12. **Design incorporates suggestions** of aircraft manufacturers. Aircraft engineers available for consultation.
13. Uses same mounting hole spaces as other reels of our manufacture.
14. Mock-up units available for your development work.

We also make Unidirectional Reels conforming to Specifications MIL-R-8236 Type MA-1 and AN-R-29 amend 2.

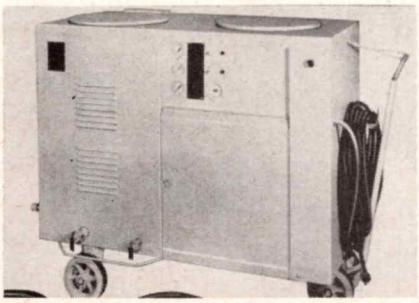
Original producer of the Inertia Locking Shoulder Harness Safety Reel. Supplier to the Armed Forces Since 1942. American Inertia Reels are fully protected by patents.

Your inquiry will be answered promptly.

American Seating Company

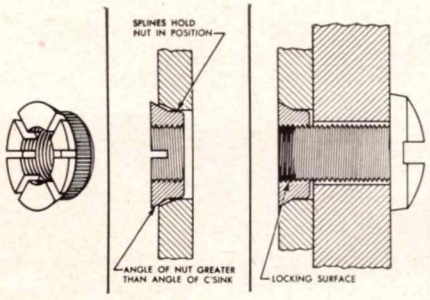
GRAND RAPIDS 2, MICHIGAN • WORLD'S LEADER IN PUBLIC SEATING

ments or for setting the scale off zero. The gaging head features—a double reed system amplifying principle that obviates the use of gear trains, levers, racks, pinions—with the lag, backlash and wear which such systems are subject to. This system makes the instrument self-compensating to temperature. Coil springs damp the reeds of the movement. Measuring pressure of the spindle is factory set and is low but constant, permitting the operator to use both hands. The column can be rotated on the base, permitting the instrument to be used with a surface plate or master flat lying adjacent to the instrument.



Steam Cleaning

Aeroil Products Co's. heavy duty Auto-Steam 200 has a steam capacity of 200 gph at 120 psi and a rinse capacity of 300 gph at 140 psi for cleaning and rinsing aircraft engines and parts. The steam is completely automatic and is powered by electricity with an automatic 10,000 v. ignition, a down draft burner, 1 hp motor, a bronze and monel positive displacement pump, 25 ft. of heavy duty super service steam hose, and a 5 ft. combination vapor and rinse steam gun with gun control shut off. The unit is 32 in. wide x 60 in. long x 45 in. high. Net weight is 800 lb.

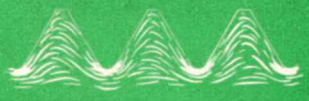


Locknut

Allmetal Screw Products Co., Inc., is marketing a solid metal piece lock-

THE NEW MS SERIES BY BRILES

Head section showing grain flow. Fillet rolled after heat treat for strength concentration.



Thread-detail showing added strength due to grain-flow from thread-rolling.

MIL-B-7838 SPECIFICATION FEATURES

1—Rolling Fillets and Threads After Heat Treat . . . (Increases Strength Through Elongated Grain Flow)

2—160,000 to 180,000 PSI to Withstand An Average of 65,000 Fatigue Cycles

3—100% Magnetic Inspection

As a pioneer producer of precision fasteners for the Aircraft industry exclusively, Briles specialized experience in cold heading and thread rolling gives the industry fasteners of the highest quality on a production basis.

BRILES MANUFACTURING COMPANY

COLD HEADED RIVETS AND BOLTS
3/32" to 1 1/2" Dia.
EL SEGUNDO, CALIFORNIA

AMPHENOL

MINIATURE

AN-type CONNECTORS

SPECIAL FEATURES:

- ★ ⅓ the weight of standard AN connectors
- ★ Pressure-proof
- ★ Waterproof, mated or apart
- ★ "O" ring sealers
- ★ Spun-in sandwich construction on female connectors
- ★ Aluminum shells with *hard-cote* grey anodic finish
- ★ Gold-plated contacts
- ★ Famous AMPHENOL 1-501 blue dielectric
- ★ Unique built-in cable strain relief

Design engineers have long requested a miniature version of standard AN connectors. And here is the answer: the new AMPHENOL 165 series of miniature AN-Type connectors have the *identical electrical qualities* of standard AN's compressed into only *one-third* the weight! Now designers of electronic equipment requiring AN connectors can utilize the 165 series instead and show substantial savings in both weight and space.

The 165 series are available in two connector sizes and six contact configurations. The small size is obtainable in 5, 9 or 12 contacts; the "large" size in 11, 14 or 24 contacts—all have male or female inserts in plug or receptacle.

For more complete information about the 165 series, write and request "Amform 2397."

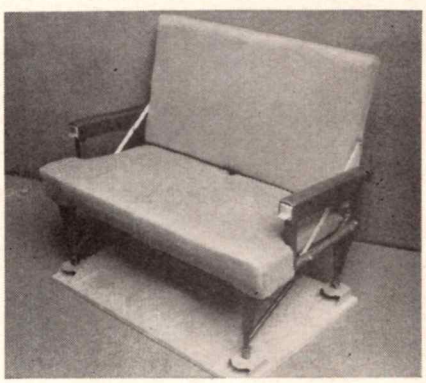
AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois

AMPHENOL

In Canada: AMPHENOL CANADA, LTD.

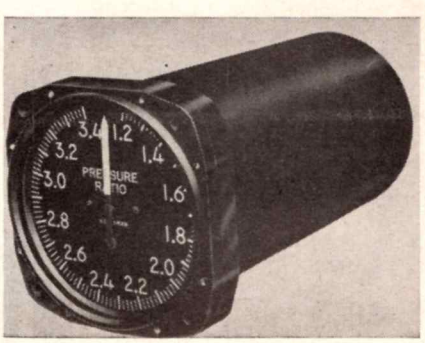
AVIATION EQUIPMENT

nut. It is slotted cone shape on one end, splined cylinder on other, and designed to be inserted in a countersunk hole. The nut is partially or completely seated in material and is held in position by force-fitted splines. After bolt is inserted and locking action is effected by the pressure of the sector threads forced against the bolt by the interference of the countersinks. It is available in all metals and in all standard thread specifications.



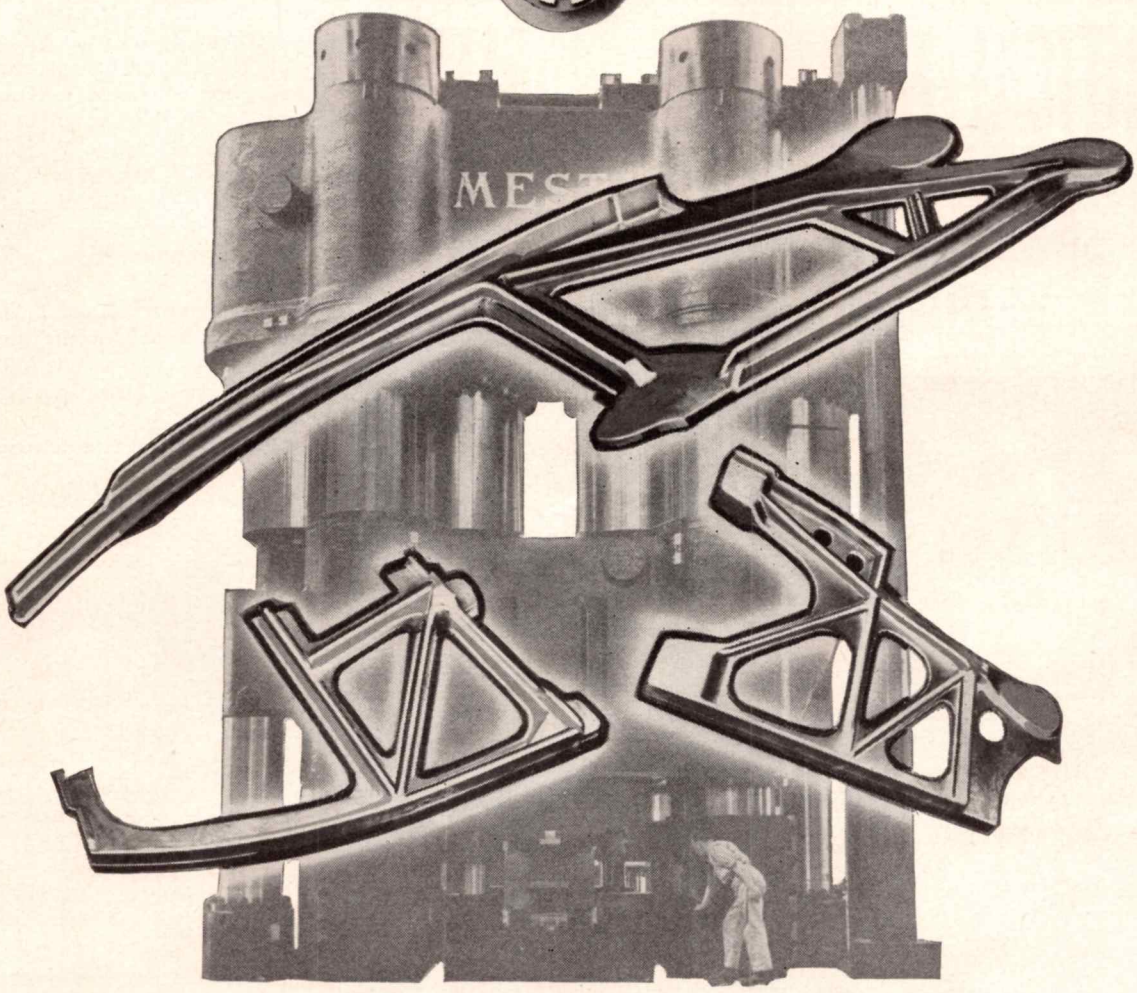
Helicopter Passenger Seat

The Aerotherm Corp. Bantam, Conn., has designed and manufactured the lightest weight aircraft passenger seat developed to date for commercial carrier use—specifically designed for use on Sikorsky's S-55 commercial helicopter. Total weight, including cushions and upholstery, is 24½ lb. Designed for 4G forward, 4G downward and 1½G side loads, Model 493-2 double passenger seat conforms to standard thickness with foam rubber back and bottom, including the armrests. The seat folds directly into and against fuselage wall in the S-55.



Pressure Ratio Indicator

A pressure ratio indicator, has been developed by Kollsman Instrument



Greater Size and Speed in Aircraft have created engineering problems, the solution of which has required larger and larger forgings of high-strength aluminum alloy. *Examples* shown above are forged structural members used in a modern military bomber, the largest more than seven feet over all. These are forged on an 18,000 ton press, the biggest ever built in this country.

Wyman-Gordon Experience—the most extensive in the industry—is keeping abreast of new forging demands involving the use of Steel, Aluminum, Magnesium, High Density Alloys and Titanium.

• • •

Standard of the Industry for More than Seventy Years

WYMAN-GORDON

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN

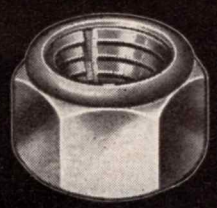
...for

CRITICAL FASTENING PROBLEMS

specify Delron

specialized fastening devices

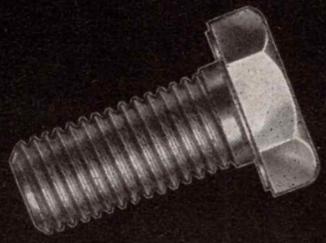
High Temp, Self-locking, Stainless Steel Nuts—Free Spinning On, Lock . . . Unlock, Free Spinning Off—Reusable.



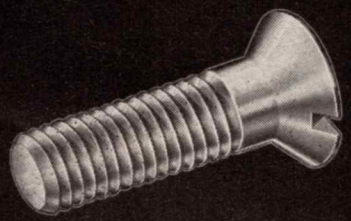
DURA-LOC 1200
(temperatures up to 1200°F.)

DURA-LOC 1600
(temperatures up to 1600°F.)

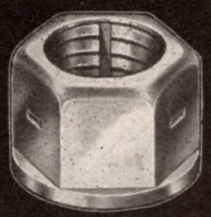
High Temp, Stainless Steel Bolts and Screws for temperatures to 1600°F. Special thread form minimizes galling and seizure—Reusable.



DELRON HIGH TEMP BOLT



DELRON HIGH TEMP SCREWS



DELRON #5 Self-locking, Stop Nut —Washer faced. Free Spinning on, lock . . . Free Spinning off after prevailing torque released—Reusable.

FASCO SPACERS Lightweight High Column Strength Aluminum Spacers for assembling and attaching to sandwich-type structural panels.

Illustrated are a few of the many Delron Specialized Fastening Devices designed to help solve your critical fastening problems!

Need data on a specific fastening problem?

Clip this ad to your letterhead, and mail for product data on items checked: AD

☐ Fasteners to 1200°F. operation
☐ Fasteners to 1600°F. operation
☐ Sandwich structure fastening

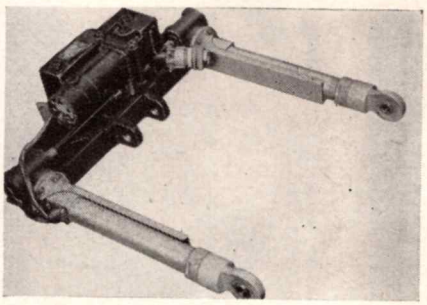
Name_____

THE DELRON COMPANY, INC.

5224 Southern Avenue, South Gate, California

Co. This new instrument indicates the most efficient power settings for climb and cruise. By indicating the ratio of total engine pressure at the tailpipe and at the inlet, the instrument tells the pilot whether or not he is getting best engine efficiency. When airborne, the jet pilot merely watches a dial and holds a given reading of pressure ratio for most efficient flight. The Kollsman Pressure Ratio Indicator can be provided with a manually adjustable temperature index. When this index is adjusted for the surrounding temperature, the exact full throttle pressure ratio for a particular field altitude is shown.

Both direct and remote reading units are available.



Seat Actuator

A new seat actuator designated the Series 2450 has been introduced by Lear, Inc., to meet aircraft requirements for a seat adjustment actuator capable of withstanding the high loads incurred by latest explosive seat ejection equipment. Maximum operating loads are 700 lb. tension or compression, and maximum static loads of 6600 lb. tension can be withstood without permanent deformation. Ultimate static strength of the new linear actuator as a heavy-duty structural member is approximately 11,000 lb., well beyond the load limits developed at the moment of explosive ejection of the seat. Exact ultimate static strengh varies somewhat with the length of the jack-screw at the time of explosion. The stroke of the jackscrew is 6.0 in., with an overall actuator length of 9.0 in. when fully retracted. Fully qualified under military environmental specifications, the operating temperature range of the unit is —65 deg. F. to 170 deg. F. Weight is 8.3 lb. Incorporating two ball bearing screws with irreversible worm drive power gearing

beyond the sonic wall

precision *spells* performance!

SPECO

• New heights of performance, demanded by supersonic flight, also demand new standards of precision . . . precision assured by the know-how and production facilities with which we have served the aviation industry in development work for many years.

We manufacture precision gear assemblies for accessory drive units, actuators, transmissions, computers and controls. And we also produce complete components such as bomb hoists, gun turrets, radar tracking and scanning assemblies, hydraulic actuators.

Make **your** development and production problems **our** problems. We're qualified by long and proven performance to solve them . . . large or small.
A letter or telephone call will put us at your service.

THE STEEL PRODUCTS ENGINEERING CO.

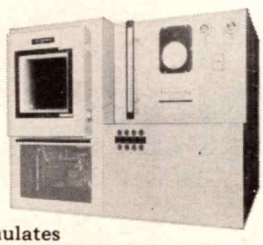
ENGINEERS AND MANUFACTURERS • SPRINGFIELD, OHIO

ENVIRONMENTAL TESTING

for TEMPERATURE
...ALTITUDE...HUMIDITY
...SAND and DUST
...FUNGUS...EXPLOSION

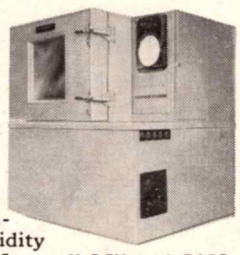
Men who know will urge you to "take your problem to Tenney." For Tenney has more specialists in test chamber engineering . . . more important installations in successful operation . . . *more experience* than any other manufacturer in this increasingly important field.

Year by year Tenney has pioneered in wider ranges of temperature and pressure . . . new refrigerants . . . precise humidification . . . and standardizing precision units like these:



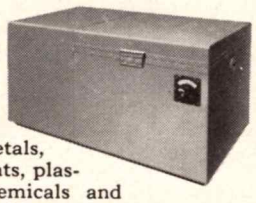
ALTITUDE CHAMBERS

Accurately simulates altitudes from sea level to 85,000 ft. Temperatures 200F to −100F. Relative humidity 20 to 95%.



TEMPERATURE AND HUMIDITY CHAMBERS

Precision recorder controllers. Temperature and humidity ranges as above. Meets all Mil and JAN specs. Variety of standard sizes.



SUB-ARCTIC INDUSTRIAL CABINETS

For testing metals, radios, instruments, plastics, liquids, chemicals and pharmaceuticals. Temperature ranges of −40F, −80F, −100F, −120F, −150F, −170F are standard for each size.

For literature on these and other units, write Dept. H104, 1090 Springfield Road, Union, N. J.

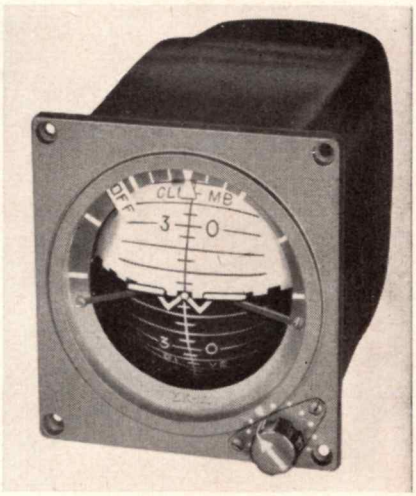
Tenney ENGINEERING, INC.

Plants: Union, N. J. and Baltimore, Md.

West Coast Representative: The Thorson Company, 1644 No. Orange Grove Ave., Los Angeles, 46, Calif.

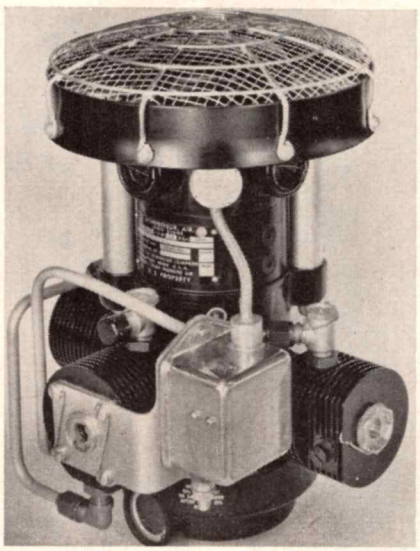
Engineers and Manufacturers of Refrigeration and Environmental Equipment 1199

coupled to a light weight power unit, the Series 2450 actuator provides the configuration required by most ejection seat applications. Drive end is equipped with clevis-type mounting accommodating a 0.5-in. dia. mounting bolt. Two 0.375-in. I.D. self-aligning, spherical balls are incorporated on the driven-end fitting. The main support bracket is fabricated of high-strength, drop-forged 75ST-6 aluminum alloy for maximum strength/weight ratio. A ball-bearing screwjack is utilized which requires no lubricant during the service life of the unit.



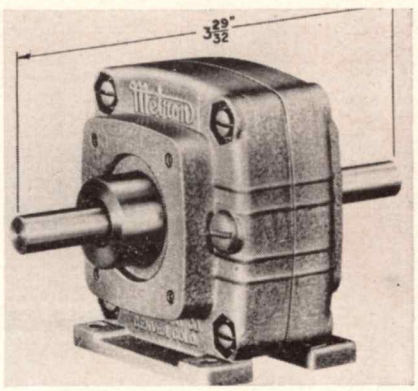
Vertical Gyro Indicator

Development of a new remote-reference Pictorial Vertical Gyro Attitude Indicator has been completed by Lear, Inc. The instrument displays a miniature reference airplane against a moving background graduated in degrees of climb or dive readable, according to tests, to within one degree. The instrument can be used to provide attitude indication for GCA and ILS approaches, instrument climb-outs and bombing or rocket runs. The spherical background of the new unit is free to move a full 360 deg. in roll without obstruction and is capable of multiple rolls without error accumulation.



Air Compressor

Cornelius Model 130R0100 three-stage compressor has a pumping capacity of 2 cfm of standard air (0.15 lb./min.) with an inlet pressure of 32 in. Hg absolute and a discharge pressure of 3000 psi. The explosion proof dc electric motor is mounted integrally with the compressor. It draws 60 amps max. at 27 v under full load. A fan is mounted on the end of the motor shaft for cooling. The compressor is designed to be supercharged with jet engine bleed air at 32 in. Hg absolute for operation above 20,000 ft. An integral oil pump and oil reservoir is located on the bottom of the compressor crankcase. Oil reservoir capacity is sufficient for a minimum of 25 hr. operation without servicing. A simple gear type pump forces oil into the crankcase where it lubricates all moving parts on the splash principle.

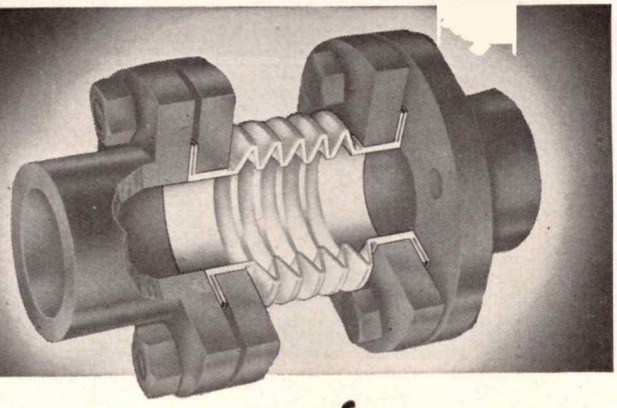


Speed Reducer

Small, yet powerful, speed reducers are now available for the first time in the new Metron "Bantam", Series 10, line. These units are designed to fill in the wide gap between Metron Miniature Speed Reducers and the bulkier "power" types. Nominally rated at 0.10 hp, these speed reducers

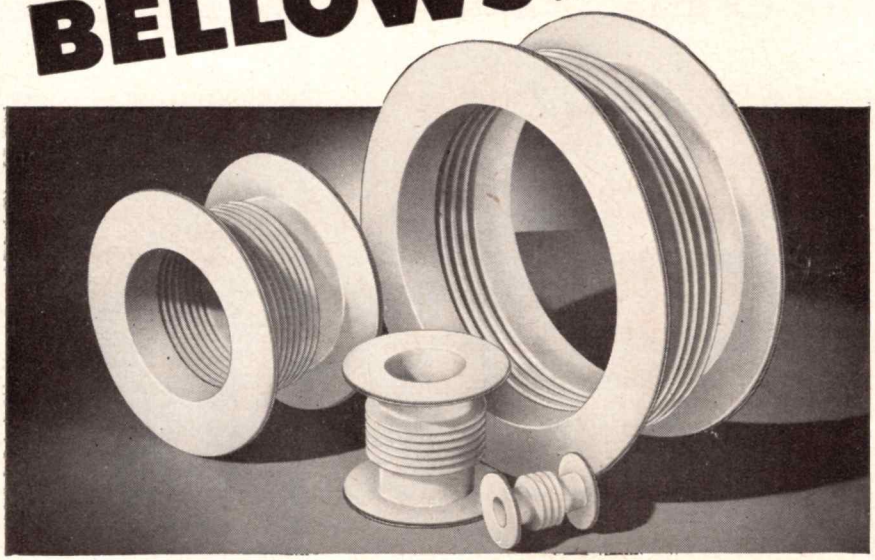
A BIG
SQUEEZE
—for you
$31,000 worth of goods per man, per year is a record we've recently established. In all the nation, few plants produce with such efficiency.
This record is important to you, the taxpayer, because it helps your Air Force make every dollar count. And making dollars count is a full-time job for men of the Air Materiel Command.
While producing economically, we also keep a quality standard unexcelled in the industry. Quality that "brings 'em back alive" when pilots need the big assist from Fletcher wing fuel tanks.
Yes, we work with an eye on the sky and a grip on the pennies. Like the Air Force, we know that they add up to *your* tax dollars.
FLETCHER
aviation corporation
World's largest designers & manufacturers of external wing tanks
FLETCHER AIRPORT • ROSEMEAD, CALIFORNIA
SERVICE OFFICES: DAYTON, OHIO • WASHINGTON, D.C.
OFFSHORE AFFILIATES: OSLO, NORWAY • TOKYO, JAPAN

NOW... to handle those difficult piping problems



JOHN CRANE

Offers a complete line of BELLOWS MADE OF TEFLON*



1. **Chemically inert** —*will handle all corrosive liquids, petroleum products, gases and solvents.*
2. **Life-long flexibility** —*will not damage or fatigue under severe vibration or repeated expansion and contraction.*
3. **Outstanding electrochemical properties** —*eliminate electrolysis in the handling of chemicals, acids, etc.*
4. **Wide temperature range** —*flex perfectly and otherwise physically unaffected over a wide temperature range.*

"John Crane" Bellows provide a positive answer in the transmission of any type hydraulic or lubricating fluid, including the newly developed synthetics. Impervious to practically all known corrosive liquids and gases, they are unaffected by temperatures from –300° to +500°F.

Made from a special densely molded stock and so machined that there is no inherent stress at their free length—*they expand and contract in either direction with equal freedom of motion.* End flanges of French-type gasket construction facilitate easy assembly and assure a leak-proof seal. Stock sizes are available in a full range of standard pipe dimensions from 1 to 8 in.

Bellows are also available in a wide range of designs suitable for metering pumps, pressure accumulators, batching scale connectors, etc.

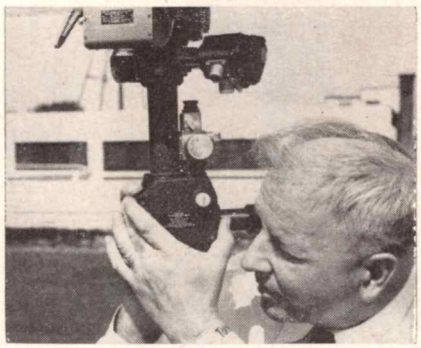
Further information on Teflon parts and products is available in "John Crane's" 12-page illustrated catalog, "The Best in Teflon." Send for your copy now. Crane Packing Company, 1841 Cuyler Ave., Chicago 13, Ill.
In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

JOHN CRANE **CRANE PACKING COMPANY**

**DuPont Trademark for tetrafluoroethylene resin.*

contain high quality, hardened steel, 48-pitch gears. Over 600 different ratios are readily available, to meet any speed changing need.

Only 2.4375 in. high and 2.375 in. wide, these "Bantam" speed reducers can be used in very close quarters. They are ideal for chart drives, computers, oscillographs, servomechanisms, etc. The 0.3125 in. diameter in-line shafts make them easy to use in existing equipment. Anti-friction bearings throughout plus a splash type oil bath, insure long, dependable, trouble-free performance.



High Latitude Compass

The Kollsman Instrument Co. Sky Compass gives the true heading of an aircraft by determining the position of the sun when it is below the horizon, giving accurate readings in high latitudes.

For true heading readings, Sky Compass uses polarized light from the sun, present in the sky when the sun is below the horizon. In an aircraft, the compass uses the same mount and power supply as the Kollsman periscopic sextant. It has a specially designed optical system using an analyzer that includes a polarizing plate and a half wave plate, the half wave plate having cutouts to produce a pattern that can be seen in the optical field. The instrument also has a periscopic tube, an illuminated bubble, and a true heading objective lens. The navigator rotates the instrument as he looks through the eyepiece. As it is being rotated, the intensity of the pattern in the analyzer varies until the compass is pointed in the direction of the sun's azimuth. In this position the pattern disappears, becoming solid gray throughout the field. This is known as the "match point." When this is reached, the navigator reads the true heading of the aircraft from the true heading scale.

ARO

Variable Speed AIR HOIST

Choice of Controls... New Pendant, push-button, instant stop or start, up or down . . . also, double cable control.

Variable Speed... 1000 lbs., 0 to 38′ per minute . . . quieter . . . no spark hazard . . . explosion-proof motor.

AIR-powered for Safety... can't burn out . . . can't overheat . . . permits continuous use . . . unaffected by dust or fumes.

Lightweight... only 28½ lbs.—overall length, 10½″.

SEE YOUR ARO DISTRIBUTOR

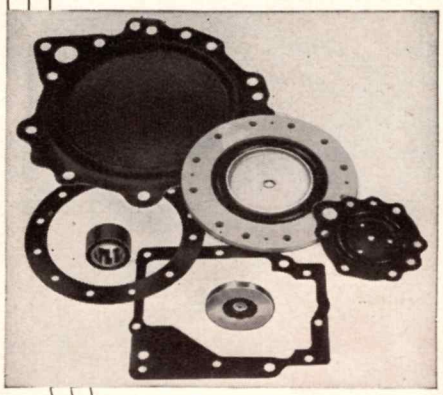
THE ARO EQUIPMENT CORPORATION
Bryan and Cleveland, Ohio

Aro Equipment of California, Los Angeles, Calif.
Aro Equipment of Canada, Ltd., Toronto 1, Ontario
Offices in All Principal Cities

ARO® AIR HOIST
Also . . . Air Tools . . . Lubricating Equipment . . . Aircraft Products . . . Grease Fittings

PRECISION

Molded Rubber DIAPHRAGMS for Aircraft



Whether on jet or piston planes, the accuracy and sensitivity of diaphragms are vital to performance and safety. For this reason more and more aircraft manufacturers are depending on AIREX for the solution to diaphragm problems.

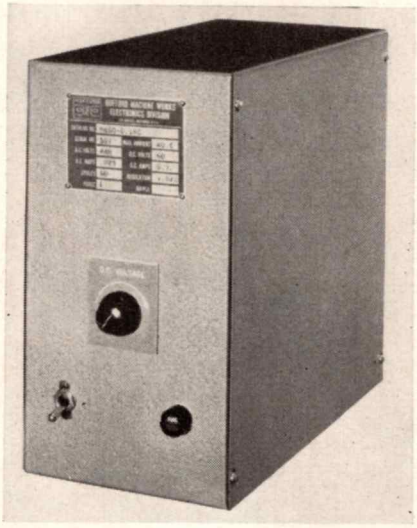
AIREX, specialists in the manufacture of diaphragms for exacting aircraft applications, combine engineering know-how with production experience to maintain extremely high quality control.

AIREX completely bonded assemblies also feature superior strength through a specially developed cementing process.

Uniform quality is assured by 100% inspection on the most modern equipment.

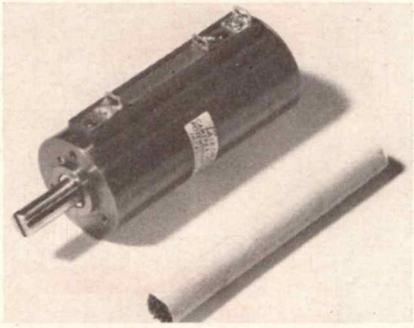
Adequate capacity to make prompt deliveries. Send us blueprints or specifications on your requirements.

AIREX
RUBBER CO., INC.
PORTLAND, CONN.
Affiliated with The Hetrick Mfg. Co.



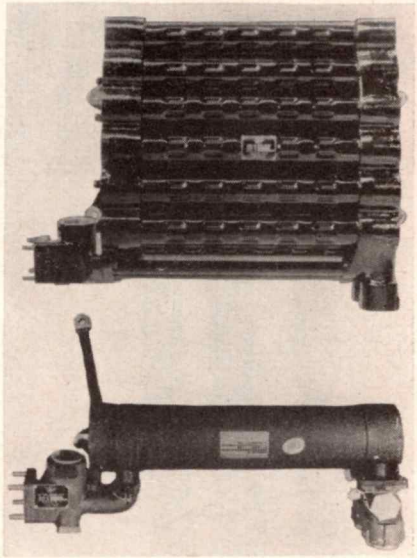
ROTA-MAG Regulator

The entry of Hufford Machine Works into the electronics field is revealed with news of a new regulator for voltage or current control. The new unit is adaptable to all d-c and 60-cycle a-c generators and high-cycle alternators. It may be used to regulate generator output on such applications as production line testing, engine starting, pre-flight check, d-c electroplating, anodizing and a wide variety of a-c or d-c exciter field combinations. It maintains voltage to plus or minus 0.3 volts up to full generator capacity, less than 0.4 volt deviation in generator output voltage results in a full swing of the magnetic amplifier output. It has a response as fast as 0.2 sec. from zero to full load, depending upon generator characteristics.



New Potentiometer

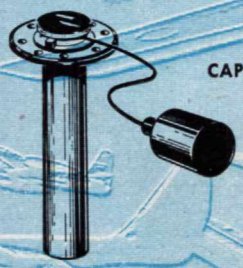
Fairchild Camera and Instrument Corp. announces the latest product of a substantial 1954 development program: a 10-turn potentiometer only one in. in diameter. Only two and one-half in. long, the unit has 26.5 in. of coil length, making it possible to guarantee accuracies of plus or minus 0.25 percent in a resistance range of 4000 to 200,000 ohms. Accuracies of plus or minus 0.1 percent are available for special applications. The unit has a starting torque of only one oz-in. and a running torque of 0.5 oz-in., making it possible to use very small servo-motors with low power. The Type 920 is available with three-hole mounting, servo mounting or threaded bushing mounting. It is gangable, uses single-wire all-welded taps and has a 0.25-in. dia. shaft.



Heat Exchangers

Small, light, clean installations for aircraft engine and airframe manufacturers are possible due to the shrunken envelopes with attendant weight savings and the highly concentrated heat dissipating passages of the new United Aircraft Products high density heat exchangers. Weights; U-513250-2, dry 20.5 lb; wet 30 lb. U-514925-2, dry 13 lb; wet 17 lb. Static pressures: oil circuit 400 psi; fuel circuit 1000 psi. Pressure drop: oil circuit 18 psi at 80 lbs/min. at 260 deg F, using MIL-L-7808; fuel circuit 50 psi at 10,000 pph at 80 deg F, using JP-4 fuel. Oil thermostatic bypass: fully open at 200 deg F, fully closed at 238 deg F. Heat rejection: with oil flow at 80 lb/min and fuel flow of 39 lb/min with oil outlet temperature of 250 deg F and fuel inlet temperature of 130 deg F, cooler will dissipate 3600 BTU/min.

LIQUIDOMETER INSTRUMENTS



CAPACITOR TYPE FUEL GAGING
by LIQUIDOMETER

THERE IS NO SUBSTITUTE FOR EXPERIENCE

The dependability of Liquidometer Capacitor Type Fuel Gaging Systems is one result of more than a quarter century of fuel gaging experience. Over this period hundreds of thousands of Liquidometer gaging systems have been manufactured for all types of aircraft. The result is a vast store of fuel gaging "know-how."

The combination of past experience plus progressive engineering methods provides Liquidometer with a sound basis for the solution of the most complex problems associated with the measurement and control of aircraft fuels.

Again, there is no substitute for experience.

THE LIQUIDOMETER CORP.

LONG ISLAND CITY 1, NEW YORK

CAPACITOR TYPE FUEL QUANTITY GAGES • LIQUIDENSITOMETERS TO PROVIDE TRUE FUEL WEIGHT INDICATION • FLOAT ACTUATED GAGES MINIATURE COAXIAL CABLE CONNECTORS • POSITION TRANSMITTERS • POSITION INDICATORS • FLOAT SWITCHES • LIQUID LEVEL WARNING SWITCHES • LIQUID LEVEL CONTROLS • CENTER OF GRAVITY CONTROL SYSTEMS AND OTHER INSTRUMENTATION

New

HARTWELL

FLUSH HEAVY DUTY COWL LATCHES

for Power Packs and Nacelle

Flush—Rugged—Positive Action—Easy to Operate—Lightweight—Simple to Install

The H-9100 Series latches are available in convex, concave and straight types. Maximum ultimate load is approximately 10,000 lbs. static tension. The toggle mechanism locks in place and applied load holds the latch closed. Simple tee-bolt and trigger opening action. They provide long, dependable service under severe operating conditions. Weigh only 9.5 to 14.2 ozs. according to materials.

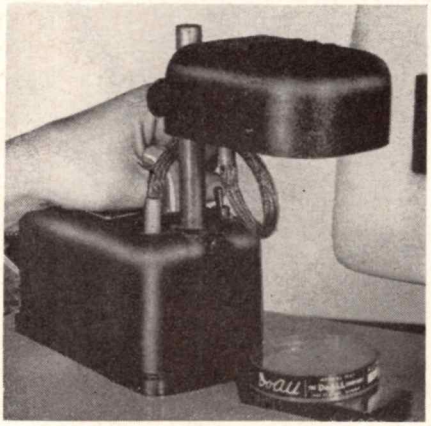
Write for complete application data.

HARTWELL

AVIATION SUPPLY COMPANY

Manufacturers of Aircraft Flush Latches and Hinges, Fittings and Cable Terminals.

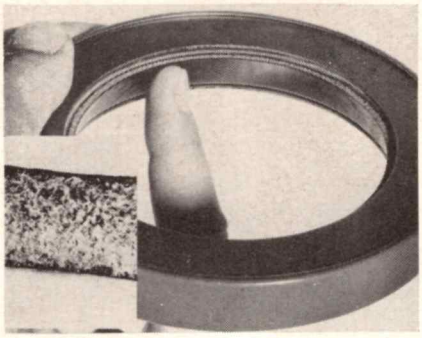
9035 Venice Boulevard, Los Angeles 34, Calif.
Branch Office: Wichita, Kansas



Monochromatic Light Generator

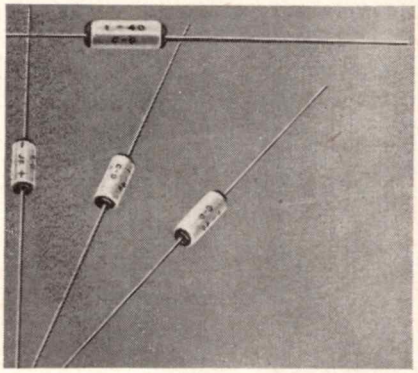
The DoALL Company has placed on the market a featherweight 2 in. monochromatic light generator for inspection of flatness, finish and size with optical flats.

It's size (7 in. long x 3½ in. wide) permits on-the-job checks, for example, right on the chuck of a surface grinder or on the surface of laps. Adequate magnetic shielding of lightweight aluminum permits inspection to be made on magnetic chucks when chuck power is on. It is designed for use directly on the work surface of a machine tool or on a surface plate. In use, the head is rotated to the rear so that it is directly over the work surface. Work is placed under the head in back of the instrument. Head is rotatable a full 360 deg. around the column. It may also be removed from the instrument for use as a hand-held light source. Light generating element in this new Monolight is helium. The unit operates on the standard 110v, 60 cycle line.



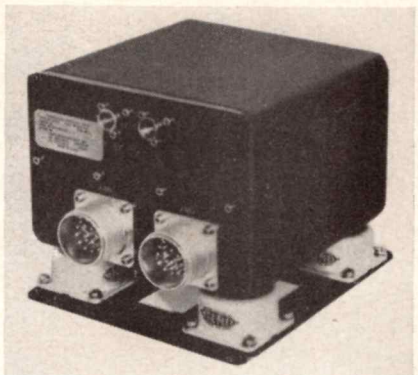
Oil Seal

A leather oil seal providing extremely low torque, cool operation, no measurable leakage and exceptional life even at 200 deg. F is now being offered by National Motor Bearing Co. It consists of a chrome-retanned leather sealing lip coated with a dry lubricant and elastomer material which renders walls of the sealing lip impervious to lubricants. The center portion of the sealing member retains the natural porosity of leather and permits the sealing member to absorb and store lubricant for use when the normal supply is exhausted. The zero-leakage performance of Micro-Torc seals shows no loss 90 percent of the time and no more than 0.5 grams per day for the other ten percent.



Tantalum Capacitors

Cornell-Dubilier Electric Corp. has developed a sub-miniature tantalum electrolytic capacitor only 3/16 in. in diameter and 9/16 in. long. Well-suited for transistor circuits, these new capacitors cover an operating temperature range of —55 deg. C. to 85 deg. C. Wound foil construction results in excellent frequency characteristics. A variety of 35 models of the new units, ranging in capacity from 0.01 mfd to 8.0 mfd and from 3 wvdc to 150 wvdc are available in both polarized and non-polarized types.



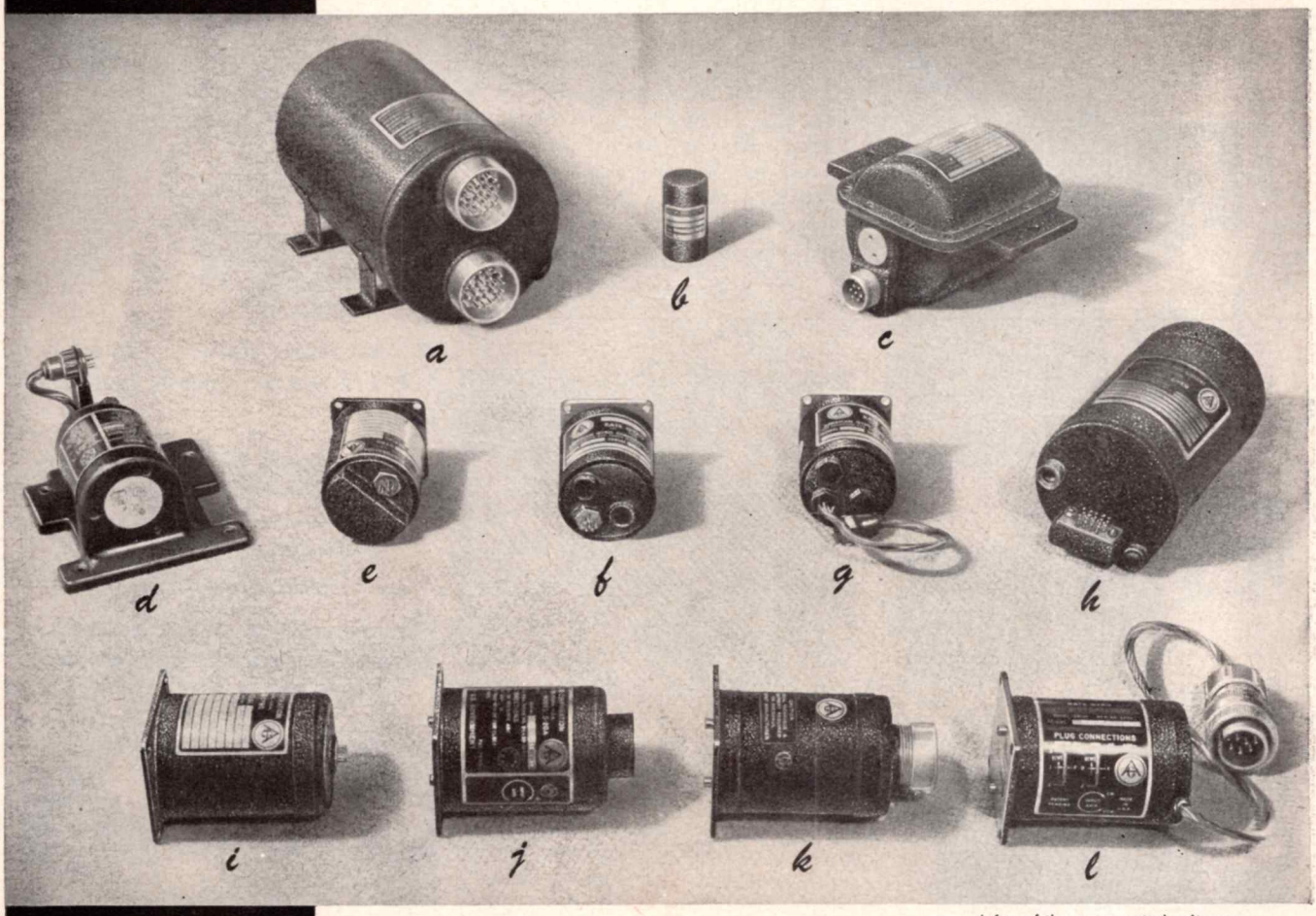
Mach Number Computer

A new lightweight, force-balance type Mach number computer which

MINIATURE

CONTROLS

GYROS–ANGULAR ACCELEROMETERS–INTERVALOMETERS–CONTROL SYSTEMS



A few of the many control units now in production by American Gyro Corporation

A. ARMAMENT INTERVALOMETER
B. SUB-MINIATURE RATE GYRO
C. VERTICAL GYRO
D. A450 RATE GYRO
E. AB100 RATE GYRO
F. B7 RATE GYRO
G. B8 RATE GYRO
H. 2-AXIS FREE GYRO
I. ACCELEROMETER
J. S20A RATE GYRO
K. A30 RATE GYRO
L. 1SB101 RATE GYRO

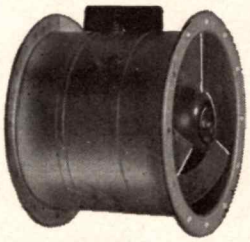
American Gyro Corporation can supply you with any type of control unit or any type of control system–completely tailored to fit your exact and individual needs.

AMERICAN GYRO CORPORATION

3030 Nebraska Ave. (Dept. B) Santa Monica, California

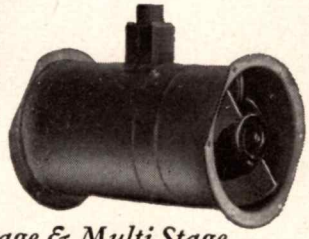
Your
BLOWER PROBLEM
is our
BUSINESS

DC
12 or 27 Volt



AC
115 V.
400 Cps

AC
208 V.
400 Cps



Single Stage & Multi Stage
Diameters 2" thru 20"

- HIGH PRESSURES
- HIGH EFFICIENCY
- LIGHT WEIGHT
- COMPACT PACKAGE
- SPECIAL SHAPES
- DEPENDABILITY

Since 1942 we have specialized in Aircraft and Electronic Blower Applications. This 12 years of "Know-How" is yours when you call us in on your Blower Requirements.

We have 100 Active Models which can be adapted to your specific requirements.

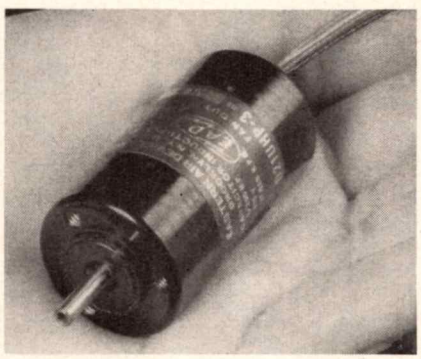
We manufacture the entire unit, including the motor, so responsibility for warranty rests squarely with us and schedules are met.

"THE BLOWER YOU NEED *IS* GUARANTEED!"

DYNAMIC AIR ENGINEERING *Inc.*
7412 Maie Avenue, Los Angeles 1, California

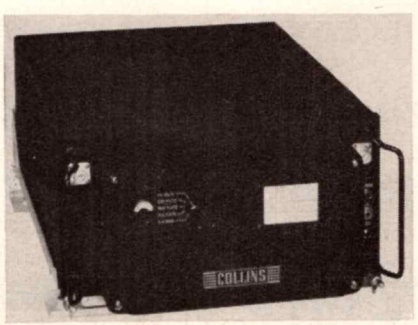
AVIATION EQUIPMENT

uses no vacuum tubes, has been developed by Servomechanisms, Inc. The new computer weighs only 4.5 lb. and measures 5.5 in. x 5.5 in. x 4 in. It is accurate to 0.01 Mach for 95 percent of laboratory test points. Known as the CA-500, the new unit is a precision 400-cycle instrument which solves the equation for Mach number through the utilization of force-balance linkage, mechanically comparing differential and static pressures. The resultant forces, developed from suitable pressure cells and compared vectorially, energizes a servo loop which balances the computer and provides an output voltage or synchro shaft displacement proportional to Mach number.



Miniature Motor

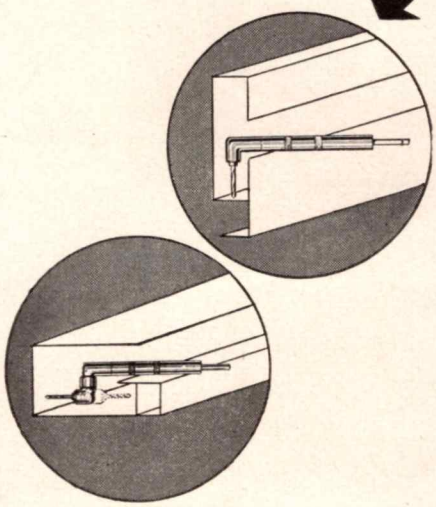
Eastern Air Devices offers an a-c motor with a diameter of only one inch. Designed for the operation of fans, blowers, instruments, controls and drives, the tiny motor develops 1/100th hp. It is a 400 cycle unit in either one, two or three cycle styles. It can be fitted with hysteresis, synchronous, servo or gear type features.



Transceiver

The Collins 618S transceiver comprises a fully-integrated transmitting

. . . FOR THESE ANGLE DRILLING APPLICATIONS



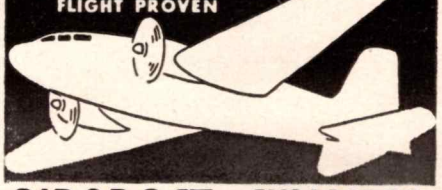
● **AND MANY MORE . . . there is a TERRY Angle or Flexible Tool to fill the bill.**

Angle Drilling TERRY Attachments (REG. U.S. PAT. OFF.)

Folder on request

GEORGE A. TERRY CO.
348 S. Elmwood Ave., Buffalo 1, N. Y.

RANDOLPH
FLIGHT PROVEN



AIRCRAFT FINISHES

- Butyrate Dope
- Clear Nitrate Dope
- Thinner
- Colored Butyrate Dopes
- Colored Nitrate Dopes
- Rejuvenator
- Aircraft Lacquers
- Retarder
- Baking Primer
- Aircraft (SG) Enamels
- Zinc Chromate Primer

"Government Specification Finishes".

Any finishing problems? . . . Write—

RANDOLPH PRODUCTS CO.
CARLSTADT, NEW JERSEY

O.K. to Jettison... in ANY attitude!

The force ejection pylon designed, developed, and produced by Pastushin assures safe, positive ejection of jettisonable fuel tanks and other external stores at *any* speed or possible flight attitude.

RESEARCH • DESIGN • DEVELOPMENT • PRODUCTION

PASTUSHIN

AVIATION CORP. Los Angeles, Calif.

Engineers: If you are not now employed in a defense industry, submit resume.

JOIN RCA ENGINEERING MANAGEMENT

RCA has two engineering management openings in its expanded electronics engineering program:

Manager Aviation Systems Electronics Development (*to supervise circuit development engineering and systems analysis of precision navigation, fire control and communications equipments*).

Manager Airborne Fire Control Product Design (*to supervise design engineering of airborne electronic equipments*).

These positions require the ability to manage a comprehensive design and development engineering organization and to plan broad engineering programs. Your ability should be substantiated by proven supervisory experience and a degree in EE, ME, or Physics.

Send a complete resume of your education and experience to:

Mr. John R. Weld, Employment Manager
Dept. B-452J, Radio Corporation of America
Camden 2, New Jersey

RCA **RADIO CORPORATION OF AMERICA**
Tmks. ®

"PUNCH" for the Nation's Air Arm!

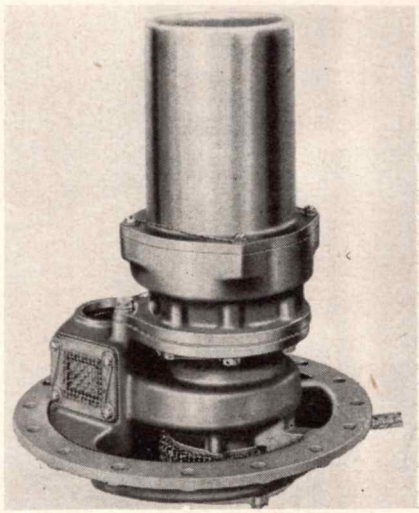
Arming a fire-pod with a Mighty Mouse... checking out a guided missile with a pre-test system... flicking the switch on an aerial camera for precision reconnaissance... three out of thousands of steps that put the punch in our air arm.

Small steps – except that the end result depends on the perfection of each step – and the perfection of these is the proud responsibility of HYCON.

Hycon Mfg. Company
"Where Accuracy Counts"
PASADENA, CALIFORNIA

AVIATION EQUIPMENT

and receiving equipment for all commercial aircraft. It contains provisions for 144 crystal-controlled frequencies in the 2.0-25.0 mc range. Automatic tuning design permits the operator to select the desired channel and all circuits within the main case are tuned automatically. Associated 180L-2 automatic tuning unit will automatically make all antenna adjustments. The transmitting section has a minimum power output of 100 watts and an output impedence of 52 ohms. Modulation capacity is 95 percent and full power operation is available to an altitude of 50,000 ft. The receiver section has an audio output of 500 mw into a 300-ohm load. Sensitivity control has a range of 60 db with a 5000-ohm external control.



Fuel Booster Pump

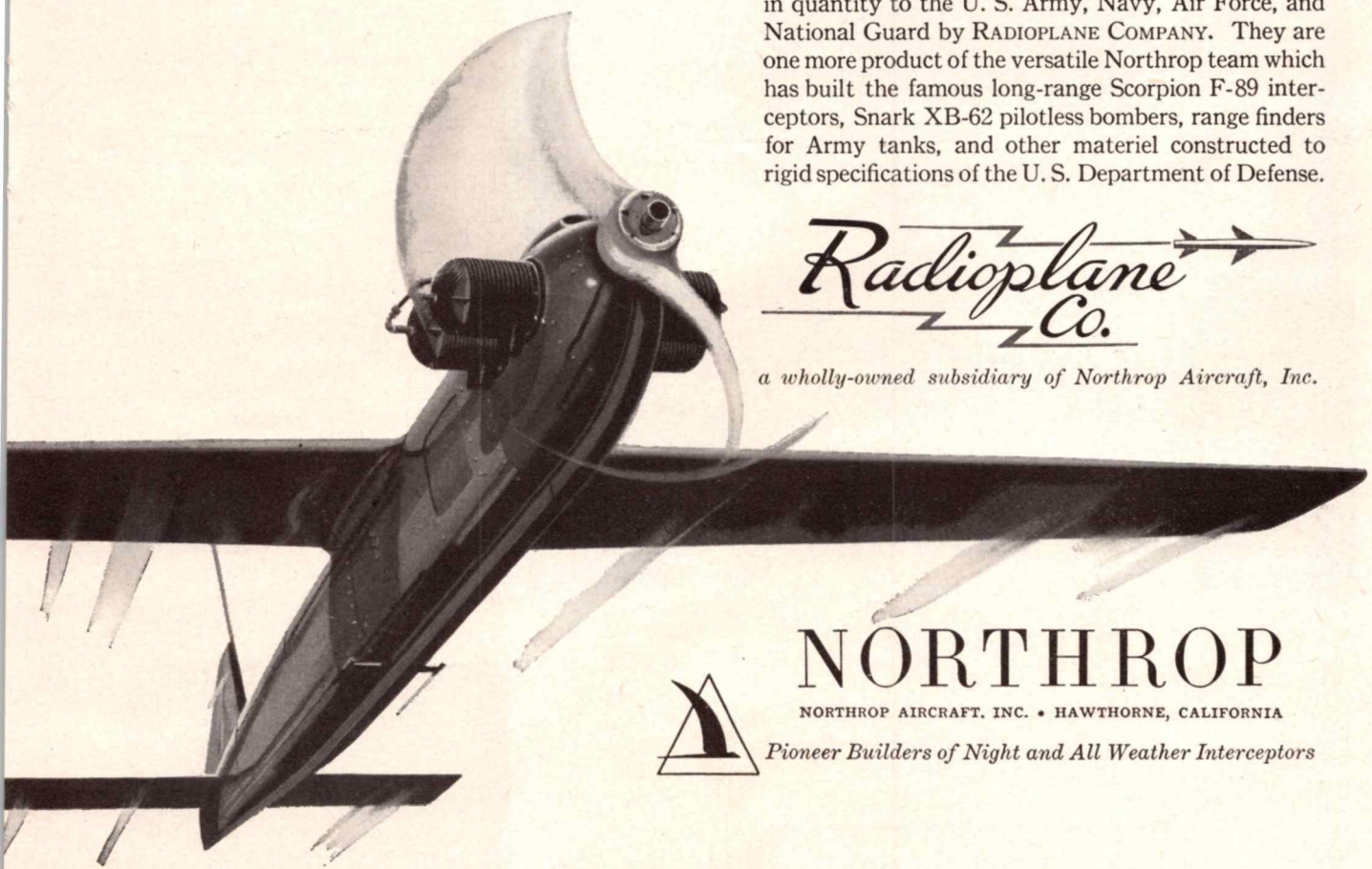
New Lear-Romeo RR-11050 totally submerged fuel booster pump is designed to separate vapor from fuel at the supply tank so that a solid line of fuel is pumped under pressure to the engine driven pump. This prevents vapor lock in the line. Performance is 6000 lb. of fuel per hour at 15 psi at any altitude from sea level to 50,000 ft. and under climb conditions as high as 7500 fpm. Pump weight is 9.25 lb. A single armature shaft, which drives the main impeller and vapor separating impeller, runs on two ball bearings and permits the pump to operate without harm under dry tank conditions. The screened inlet located in the sump is removable with the sump cover for cleaning. The motor is 0.47 hp, 27-v dc, 20-21 amps at rated load and operates at 8000 rpm.

R C A T's

Radio Controlled Aerial Targets—called R-CATS—are now the standard targets used in gunnery training of fighter pilots and anti-aircraft and airborne gunnery crews of the Armed Forces. These drones are maneuvered from the ground to simulate the attacks of an enemy; aloft they are an inexpensive substitute for "the real thing". Precision-built R-CATS are supplied in quantity to the U. S. Army, Navy, Air Force, and National Guard by RADIOPLANE COMPANY. They are one more product of the versatile Northrop team which has built the famous long-range Scorpion F-89 interceptors, Snark XB-62 pilotless bombers, range finders for Army tanks, and other materiel constructed to rigid specifications of the U. S. Department of Defense.

Radioplane Co.

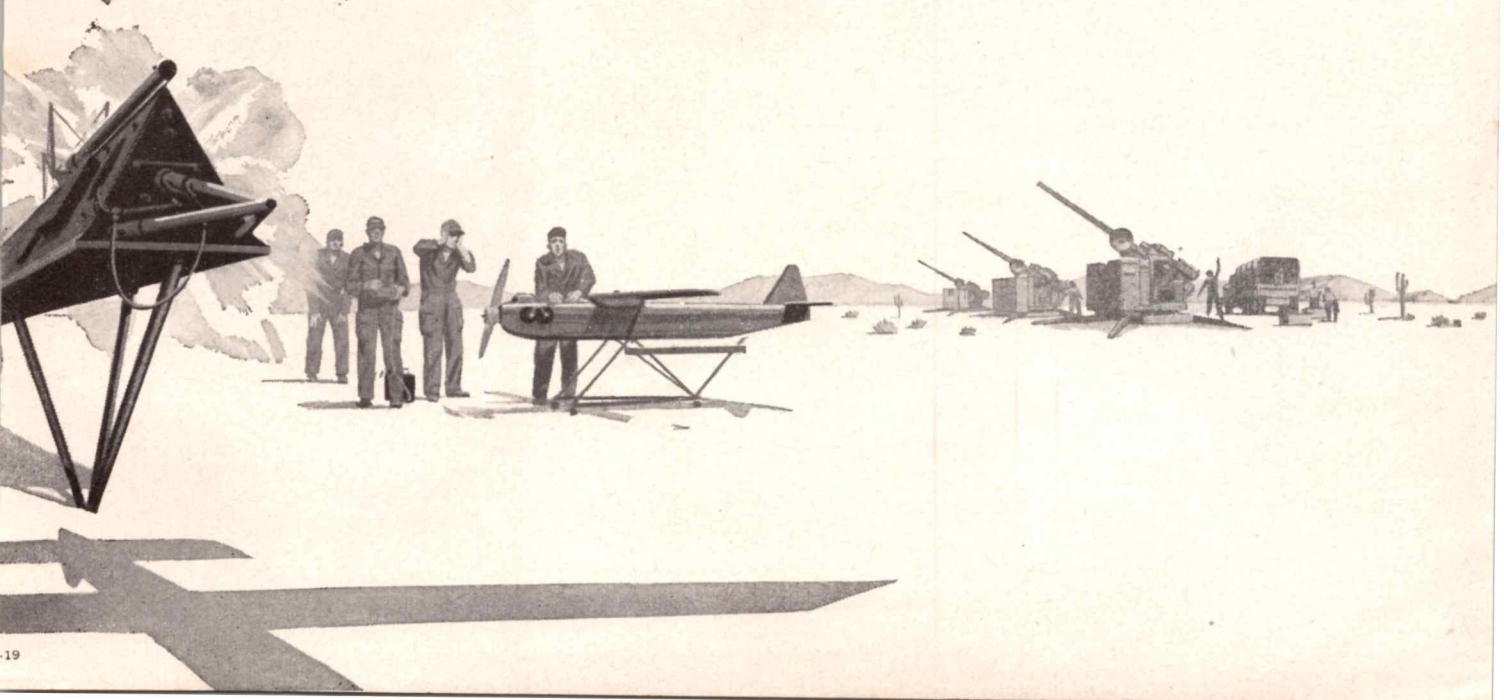
a wholly-owned subsidiary of Northrop Aircraft, Inc.



NORTHROP

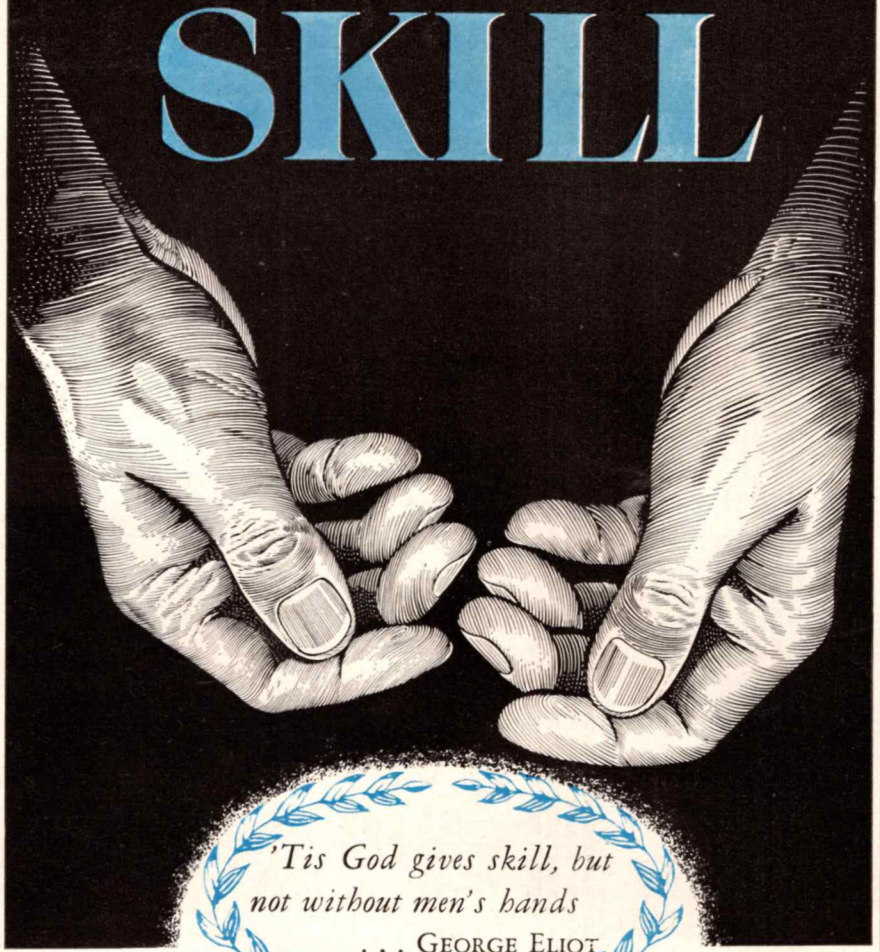
NORTHROP AIRCRAFT, INC. • HAWTHORNE, CALIFORNIA

Pioneer Builders of Night and All Weather Interceptors



VITAL, INVISIBLE PART OF EVERY CORNELIUS PRODUCT

SKILL

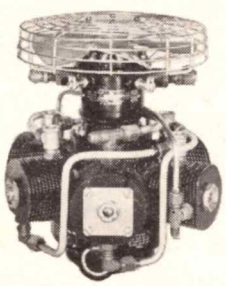


'Tis God gives skill, but not without men's hands
. . . GEORGE ELIOT

Skill is the wedding of a man's mind with his hands. Chances are you will never see the skilled hands that manufacture Cornelius products . . . for they are many, of many skills. You will, however, see proof of their skilled talents in the reliable performance of every product that bears the name *Cornelius*.

The skill, of which we speak so proudly, is the kind that satisfies man's search for perfect craftsmanship. Vital, but unseen, it's yours in every Cornelius product.

Because it makes sense to seek skill...it makes sense to see Cornelius for information and assistance on any pneumatic problem. All our skill is ready to help *you*.

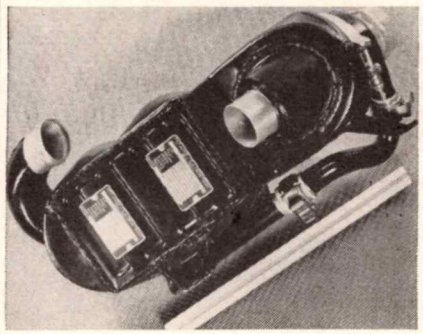


Cornelius Compressor
4 CFM—3000 PSI

THE Cornelius COMPANY
MINNEAPOLIS 21, MINNESOTA

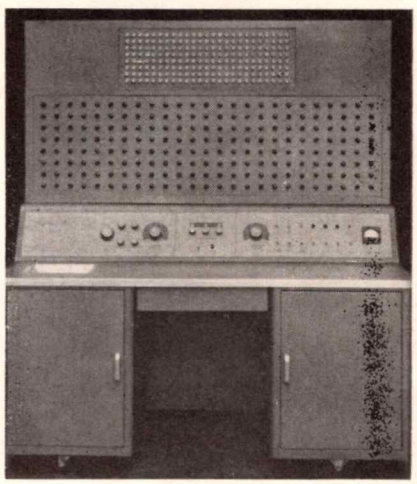
PIONEERS IN THE DEVELOPMENT OF PNEUMATIC SYSTEMS FOR AIRCRAFT

AVIATION EQUIPMENT



Refrigeration Unit

New type aircraft turbine refrigeration units that incorporate a number of unique design features to cut weight in half have been developed by AiResearch Manufacturing Company of Los Angeles, original developer of this equipment for aircraft. One unit weighing only 5.8 pounds has a cooling air flow rate of 10 pounds per minute, and produces .67 tons of refrigeration. A larger unit now in production weighs 47.5 pounds and has an output of 64 pounds of cooling air per minute. Most radical change is in reducing weight by integrating parts to eliminate many bolts, nuts, screws, washers and other steel parts. The cooling turbine is attached directly to the heat exchanger inlet, eliminating the need of a duct to carry cool air from the turbine to the heat exchanger.



200-Channel Recorder

The Beckman Recorder automatically scans up to 200 channels of information in rapid succession and prints a permanent graphical record of each measurement on an individual card. Each observation and recording can be completed in less than 1.5

21,000 tons

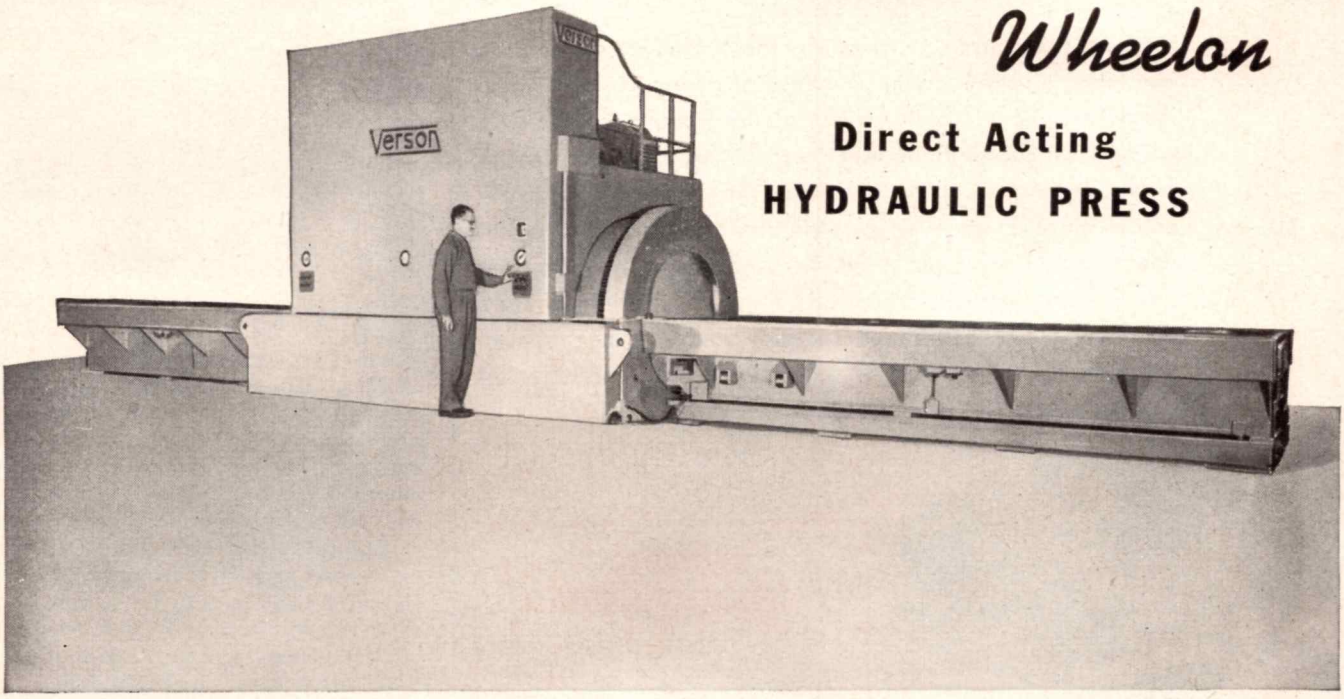
of gentle, squeezing power in this

TRADE **Verson** MARK

Wheelon

Direct Acting

HYDRAULIC PRESS



The Verson-Wheelon Bulletin explains the simple operation of the Verson-Wheelon Press and shows examples of the work it performs. Typical specifications are also given. It is available on request.

Yes, this Verson-Wheelon Press has a capacity equivalent to a 21,000 ton rubber pad forming press. However, it does a better, more complete forming job than the rubber pad press; yet its cost is only a fraction of that of the conventional press.

The Verson-Wheelon Press illustrated operates at 5,000 psi. Its twin feeding tables are each 50″ x 168″ to handle long channels for a leading aircraft manufacturer.

If you are now doing or contemplating rubber pad forming, you should consider a Verson-Wheelon Press before you buy. Compare the price and compare the work—it's the best way to convince yourself of the economy of Verson-Wheelon forming. The bulletin described at the left gives full information. Write for your copy, today.

A Verson Press for every job from 60 tons up.

TRADE **Verson** MARK

ORIGINATORS AND PIONEERS OF ALLSTEEL STAMPING PRESS CONSTRUCTION

VERSON ALLSTEEL PRESS CO.

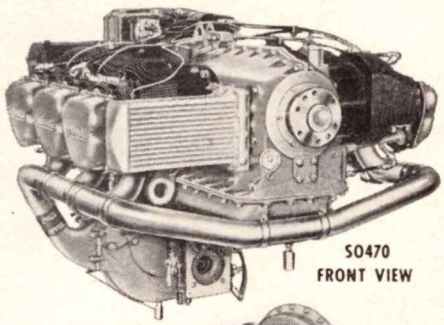
9342 S. KENWOOD AVENUE, CHICAGO 19, ILLINOIS • SO. LAMAR AT LEDBETTER DRIVE, DALLAS, TEXAS

MECHANICAL AND HYDRAULIC PRESSES AND PRESS BRAKES • TRANSMAT PRESSES • TOOLING • DIE CUSHIONS • VERSON-WHEELON HYDRAULIC PRESSES

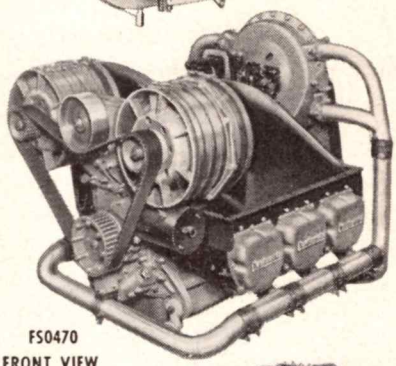
more power... ...better power

. . . TOMORROW'S POWER TODAY

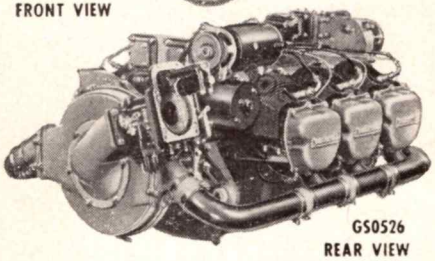
Here are three more reasons why tomorrow's finest aircraft, like today's, will fly with Continental power. Two of them represent further developments of the famous 0470 series —one supercharged, the other supercharged and fan-cooled expressly for helicopter use—while the third is a brand new power plant, engineered and built with the needs of multi-engine utility planes in mind. They have one thing in common: as products of the pioneer in power for utility aircraft, all three rate high in those qualities which go to make up dependability—qualities which have made Continental engines fliers' undisputed first choice.



S0470
FRONT VIEW



FS0470
FRONT VIEW



GS0526
REAR VIEW

GENERAL SPECIFICATIONS

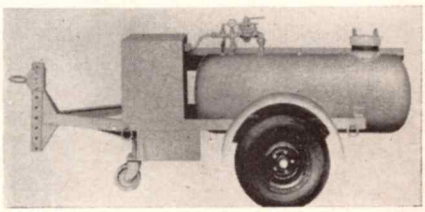
	S0470	FS0470	GS0526
Horsepower	250	260	290
R.P.M.	2600	3000	3000
Alt. (ft.)	10,000	10,000	15,000
T.O. Power (Sea Level)	265	260	320
Length (in.)	37.73	39.64	52.28
Height (in.)	30.77	34.81	23.96
Width (in.)	33.62	33.62	34.68
Bore (in.)	5.00	5.00	5.125
Stroke (in.)	4.00	4.00	4.25
Displ. (cu. in.)	471	471	526
Comp. Ratio	6.0:1	6.0:1	6.0:1
Total Dry Wt. with Accessories (lbs.)	512	550	578
Type of Prop. Drive	Direct	Direct	Geared .688:1
Recom. Fuel Octane	91/96	91/96	91/96
Supercharger Ratio	12.45:1	10.13:1	12.0:1
Supercharger Drive	Belt	Belt	Gear

CONTINENTAL MOTORS — Powerful as the Nation — AMERICA'S STANDARD ®

ONLY CONTINENTAL BACKS YOU WITH ESTABLISHED WORLD-WIDE SERVICE

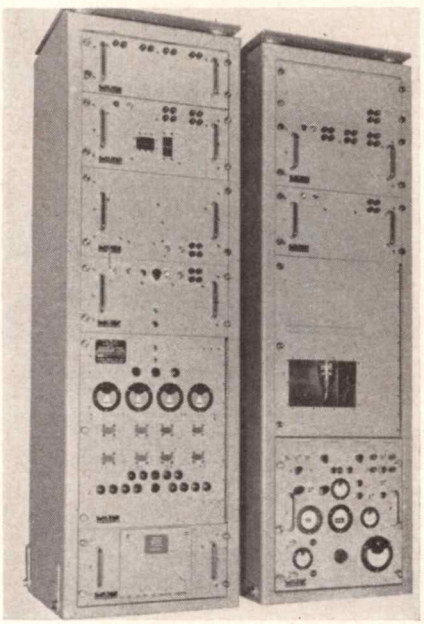
Continental Motors Corporation
Aircraft Engine Division
MUSKEGON, MICHIGAN

sec. and the entire cycle of 200 measurements in less than five min. Intervals between successive measurements can be lengthened from 1.5 sec. to any desired time. Any channel or group of channels can be selected for observation or recording, either manually or automatically. Designed to record strain gage outputs, the recorder can be adapted to record any variable that can be transformed into electrical signals.



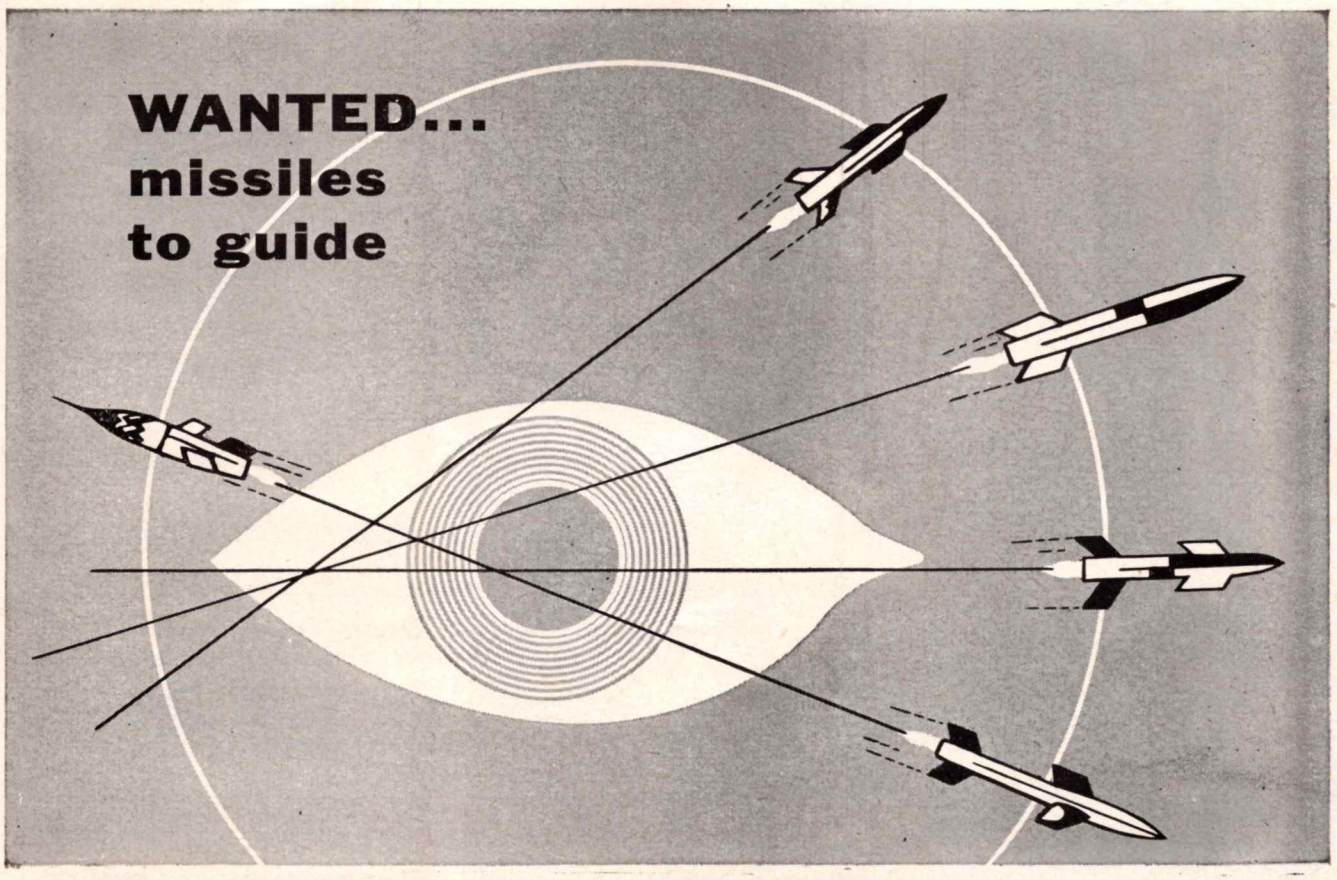
Spray Cleaner

Aeroil Products Company has a new all-steel, 120 gal. spray cleaner for cleaning aircraft engines and airplanes, and for spraying de-icing fluids on fuselages. The spray cleaner is trailer mounted. Pressure is supplied by a heavy-duty air compressor driven by a 4 cycle gasoline engine. Three sets of two nozzles each gives the operator the choice of light conical, heavy conical, or flat spray pattern. Two 50 ft. lengths of cleaning fluid resistant hose and two 5 ft. spray bars, allow simultaneous use by two operators.

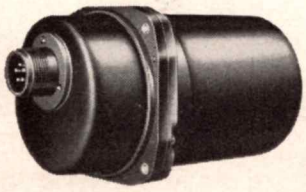


Missile Test

Hycon Mfg. Company, Pasadena, Calif., performs same work in four major fields—photography, ordnance,

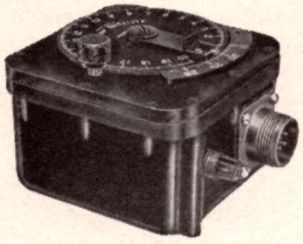


Transmitters and Monitors of proven accuracy and reliability



SYNCHROTEL TRANSMITTERS

for the remote electrical transmission of data such as true airspeed, indicated airspeed, absolute pressure, log absolute pressure, differential pressure, log differential pressure, altitude and Mach number.



PRESSURE MONITORS

to provide control signals which are functions of altitude, absolute pressure, differential pressure, etc.

To CONTROL a guided missile effectively and absolutely is a challenging problem with which hundreds of engineers are grappling every day.

The solution depends upon the efficiency and the reliability of the controlling parts.

For over 25 years Kollsman has been making precision aircraft instruments and equipment used on military and commercial aircraft throughout the world. The talents and skills needed for success in this special and challenging field are equally necessary in the design and manufacture of precision controls for missiles.

Kollsman is presently making Transmitters and Monitors of proven accuracy and reliability for missile control.

Brochures are available on the above two products.

Please write us regarding your specific problems or requirements in the field of missile control.

kollsman INSTRUMENT CORP.

80-06 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

JUST OUT!

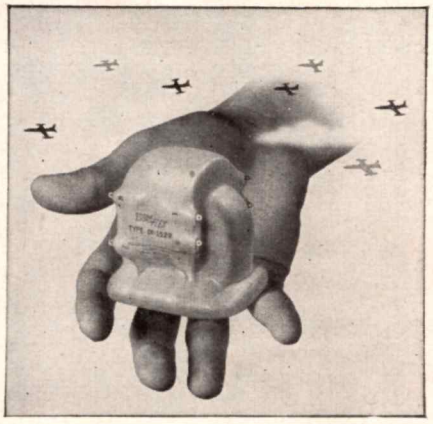
NEW 20 PAGE CATALOG

colorfully illustrates our facilities and services in the manufacture of high precision instrument gears.

Requests on business letterheads will be honored promptly. Please address Dept. A

MICRON GEAR MANUFACTURING CO.

102-38 CORONA AVENUE, CORONA 68, NEW YORK



HERE IT IS!

Hermetically Sealed

CLASS H

Open Type Transformer

POSSIBLE ONLY WITH

FORMFLEX

Designed for long life at "Hot Spot" temperatures of 200°C, permitting weight and size reductions over class A designs. Hermetically sealed (MIL-T-27) Grade 1, using exclusive FormFlex process.

AIRCRAFT TRANSFORMER CORPORATION

Manufacturers of Inductive Equipment
1 West Avenue, Long Branch, N. J.

FLIGHT INSTRUMENTATION *by* RAHM

potentiometer type transducers for use at temperatures between −60°C. and +160°C.

Designs available permit single or multiple range linear output from non-linear input function, and operation over wide ranges of environmental conditions.

for

- **PRESSURE**
- **ALTITUDE**
- **AIRSPEED**

- **ACCELERATION**
- **PRESSURE SWITCHING**
- **ALTITUDE CONTROL**

Designs available for operation to 285°C.

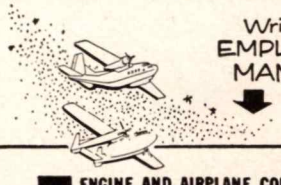
Request Catalog #653.

RAHM INSTRUMENTS, INC.

12 WEST BROADWAY, NEW YORK 7, N. Y.

New Aircraft Projects

mean that we must constantly expand our creative engineering group. There are openings now for engineers experienced in vibration and flutter. *Must have a minimum of three years' experience.*



Write our EMPLOYMENT MANAGER

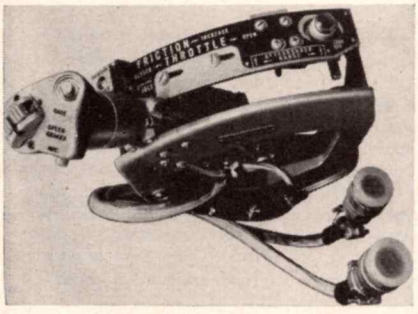
ENGINE AND AIRPLANE CORPORATION

FAIRCHILD

Aircraft Division

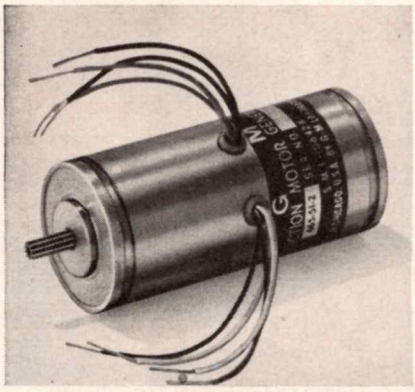
805 PENNSYLVANIA AVENUE
HAGERSTOWN, MARYLAND

electronics and aerial surveys. Guided Missile Test Set AN/DSM-2 is an electronic unit designed specifically for testing surface to air guided missiles before they are launched. This test set automatically indicates whether or not such missiles are ready for flight and if not, helps to trace the source of trouble.



Control Quadrants

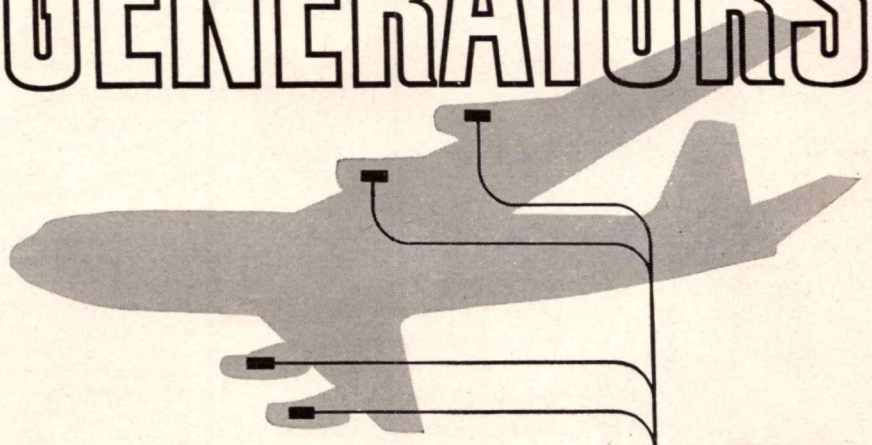
A major source for engine control quadrants for both piston and jet engine aircraft is Adams-Rite Mfg. Co., Glendale 4, California. The Company designs and manufactures the units to customer specifications. The quadrant shown here is in current production for a modern jet fighter and incorporates the latest in throttle grip design. The units are supplied complete with wiring and connectors.



Tachometer Generator

A servo motor with tachometer generator is announced by G-M Laboratories for use in servo controls. Weighing only four oz., the dual unit is less than one inch in diameter and is 2-5/32 in. long. Both stators are completely imbedded in an insulating com-

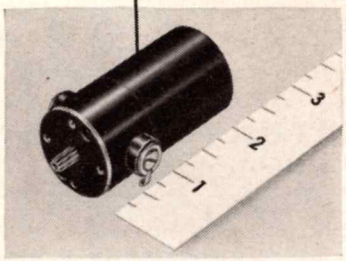
TACHOMETER GENERATORS



Transmitters of RPM information from remotely located shafts

By generating a voltage proportional to the shaft speed, these miniature generators provide rate of rotation information for electronic or instrument applications.

You can always depend on Oster for quality in miniature motors or generators for instrument or control installations.



Oster permanent magnet tachometer generator. Has linear voltage-speed characteristics over wide speed range.

Insure dependability... specify Oster®

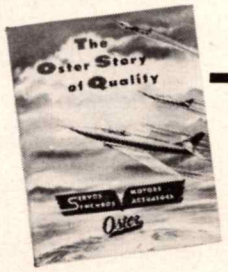
John Oster MANUFACTURING CO.
AVIONIC DIVISION
RACINE, WISCONSIN

Mail this coupon for your copy of our illustrated pamphlet No. 974 on Oster Avionic Products.

Other OSTER Avionics Products Include

- **Instrument Control Motors** *Servos, Synchros, Servo-Tachometers*
- **Servo Torque Units**
- **Motor Driven Blowers and Fans**
- **Aircraft Actuators—** *Linear and Rotary*
- **Fractional HP Motors, DC**
- **AC Drive Motors**

Oster Avionic Products are designed to meet military specifications for altitude, humidity, temperature, shock, vibration, fungus, salt spray and life.



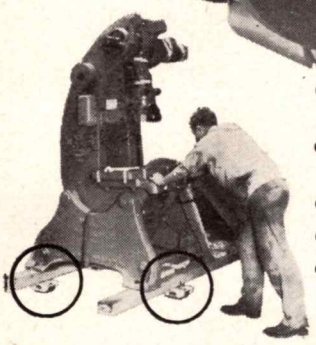
JOHN OSTER MANUFACTURING CO., AVIONIC DIVISION
Dept. 4010, Racine, Wisconsin, U.S.A.
Please send, postpaid, your catalog of OSTER Avionic Products.

NAME _____ TITLE _____
FIRM _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

move machinery and other heavy loads easily and economically with

the New improved **MULTITON** TRADE MARK **roller skid**

a midget in size...
a giant in strength



- **UNLIMITED carrying capacity.**
- **MAKES TURNS in any direction – even 90° turns**
- **LIGHTWEIGHT**
- **SELF-LAYING TRACK**
- **ONE-PIECE finest alloy steel construction**

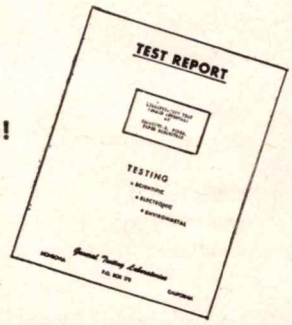
Write today for free catalog & specifications

STOKVIS ✡ EDERA & co. inc.

18 Secatoag Ave., Dept. C Port Washington, N. Y.

Laboratory Testing

of Electronic and Electro-Mechanical Components



Qualification Under All Environmental Conditions!

YOUR GUARANTEE that your product will meet all SERVICE REQUIREMENTS

The prime purpose of General Testing Laboratories is to provide a complete service in the field of environmental testing. Our reliability record is attested to by our many customers who continually receive accurate and dependable test data relative to their product's performance under all possible combinations of anticipated service conditions.

The services of General Testing Laboratories are divided into two basic categories, namely research and development testing, and complete qualification (type or brand approval) testing. Research and development tests are performed to your exact specifications. All test data and evaluations of any product are kept in strict confidence and become the property of the customer. A certified test report is provided with each project.

Write for Illustrated Brochure.

GENERAL TESTING LABORATORIES

Telephone ELliott 8-0168

227 WEST CHESTNUT, MONROVIA, CALIFORNIA

CONTINUOUS TUNING

FROM 50 TO 200 Mc

No time lost in switching from one frequency range to another. Has 72-inch direct reading dial, masked so as to show only the frequency region of interest.

This highly-sensitive, selective AM-FM receiver delivers full professional quality performance in airways, police and other general communication applications . . . in direction finding . . . and in laboratory work. Speaker and all features normally needed are included as integral parts of the receiver. In addition, special outputs are provided for the operation of an external speaker and auxiliary units to facilitate use of the receiver as a component in complete communication, telemetering and direction finding systems.

It's compact—8¾" high by 19" wide. For detailed specifications, write Dept. AD-10 SC 116

SERVO CORPORATION OF AMERICA

New Hyde Park, New York

KATO GENERATORS and ELECTRICAL EQUIPMENT

. . . your assurance of a job well done!

A.C. GENERATORS
500 Watts to 300 K.W. in one or two bearings in speeds of 720 to 3600 R.P.M. at 60 cycles.

A.C. GENERATORS
15—800 cycle, single, 3 phase.

D.C. GENERATORS
Up to 15 K.W.

ROTARY CONVERTERS

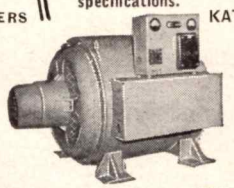
HIGH FREQUENCY CHANGERS

MOTOR GENERATOR SETS
D.C. to A.C., A.C. to D.C. — 25 cycles to 60 cycles, 60 cycles to 400 cycles.

D.C. MOTORS to 10 H.P.

D.C. MOTORS with A.C. Take-Off

KATO has been building special electrical equipment and machinery since 1928 to meet rigid military and civil specifications.



KATO GENERATORS
Many sizes available with direct or belted exciter. Odd frequencies from 25 to 400 cycles our specialty.

Write Regarding Your Special Requirements

KATO *Engineering Company*

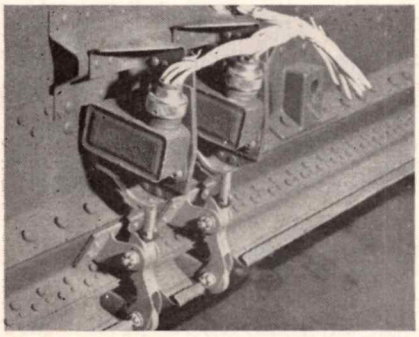
FREE LITERATURE!
1465 FIRST AVENUE
MANKATO, MINNESOTA

BOWERS BATTERIES

Always Better

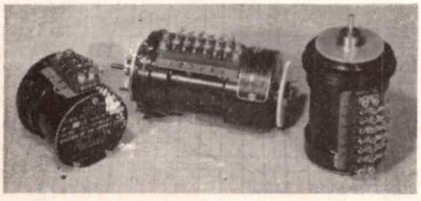
BOWERS BATTERY & SPARK PLUG CO., READING, PA.

pound of high dielectric strength and high temperature stability. The motor is a two-phase unit with an input of 26 v per phase at 400 cycles. Power input is 3.75 watts per phase. Stall torque is 0.35 in-oz. and the unit has a no-load speed of 6500 rpm. The generator provides an output of 0.32 v per 1000 rpm.



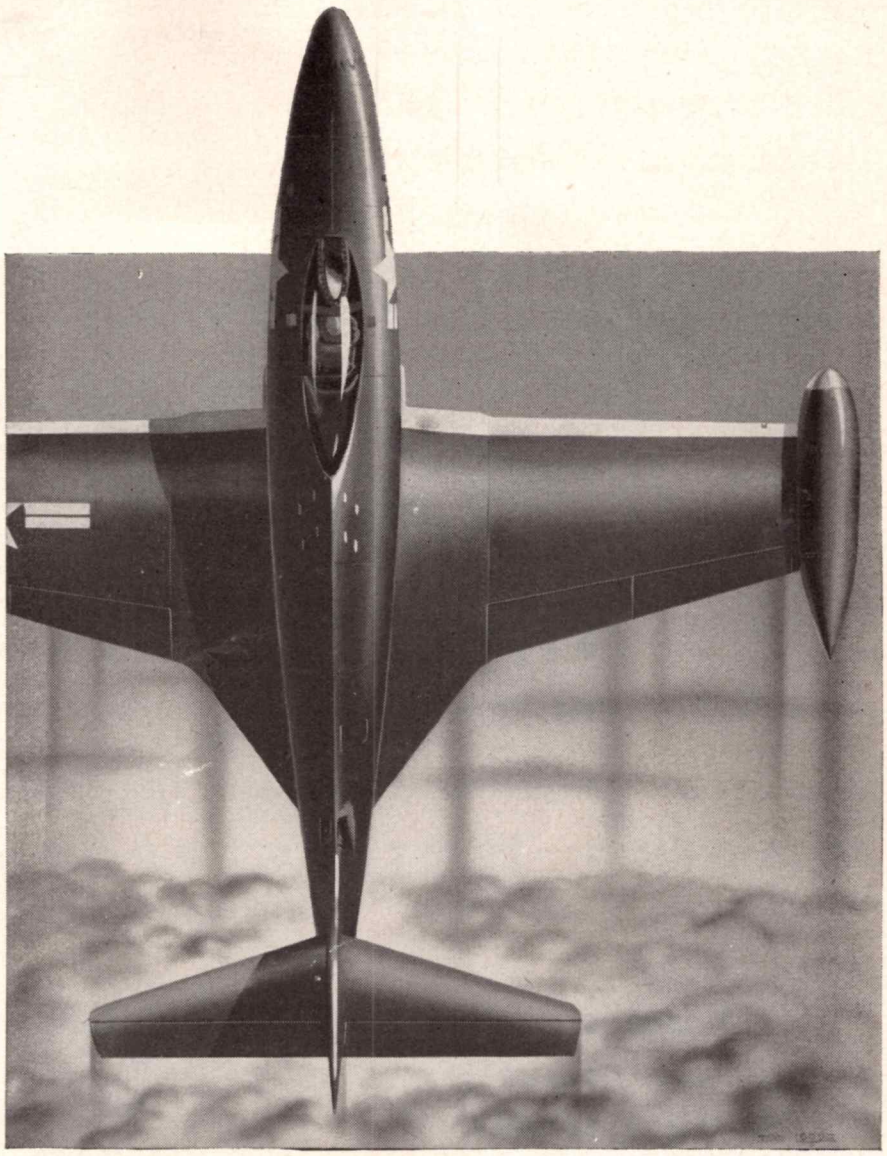
Environment Free Switch

The new Electro-Snap Switch and Mfg. Co. hermatically-sealed limit switch is virtually impervious to environment and will operate when completely immersed in water or coated with ice. All joints are copper brazed, the electrical leads are imbedded in a glass-to-metal header, the teflon and silicone diaphragm is bonded in place and the interior sealed in an inert gas. Latest installation is use as a bomb safety switch and a bomb salvo switch anchored in the bomb bay of the Convair B-36 bomber as part of the bomb release circuit.



Miniature Clutches and Brakes

A line of magnetic clutching and braking devices has been developed by Ford Instrument Co., Division of The Sperry Corp., for application in computers and mechanisms that require a high order of clutching and braking accuracy. The new units include a single clutch, a double clutch, and a clutch brake (shown in that order from left to right in the illustration). These units provide the advantages of: continuous operation (can be energized for indefinite periods); immediate release upon de-energizing; extremely rapid "pull-in"; negligible steady state



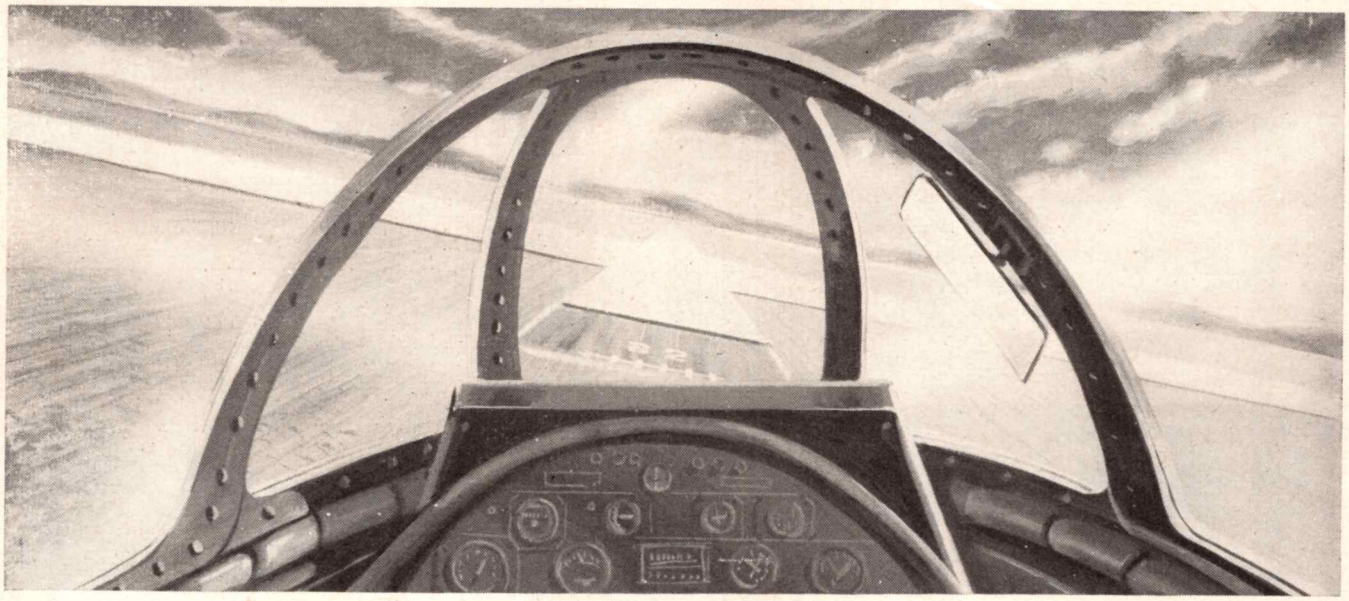
RAISE THE ROOF!

"Pour it on, mister, get up there—FAST!" Jets are climbing higher all the time—*raise the roof!*

They must withstand incredible stress without fatigue. The men who build jets depend on Lavelle for the very highest standards of stainless steel and aluminum airframe and component fabrication. Their experience has given Lavelle an industry-wide reputation as a reliable subcontractor.

Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.



THE BROADER VIEW

Our complete and integrated services to the aviation industry—normal screen motion pictures, sound slide-films and other related audio-visual presentations—now include experienced CinemaScope and anamorphic photographic techniques for wide screen applications.

WILDING PICTURE PRODUCTIONS, INC.

1345 Argyle Street, Chicago 40, Illinois Telephone: LOngbeach 1-8410 Teletype: CG 1058

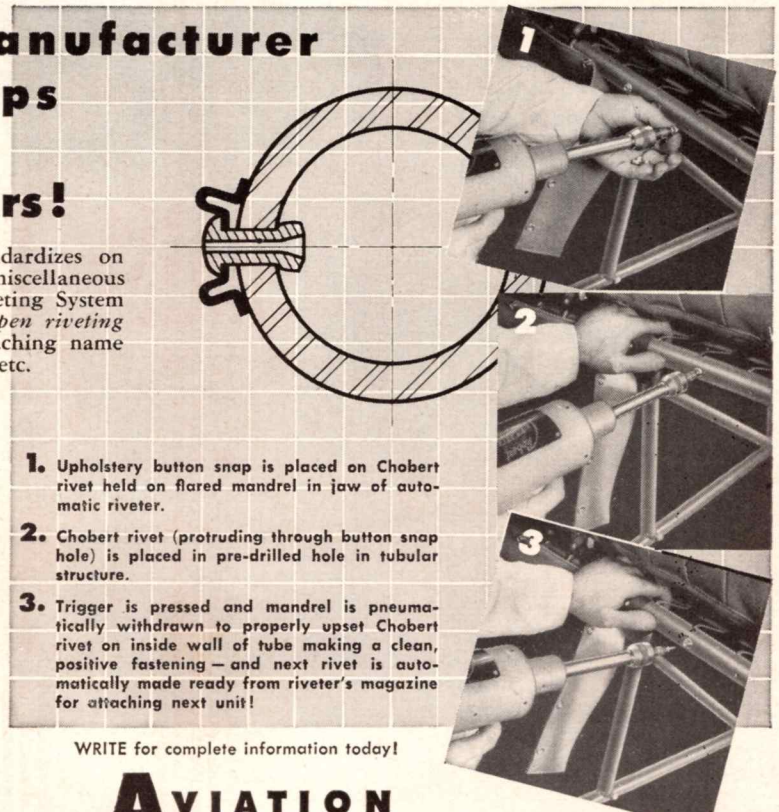
---

how another manufacturer saves production steps with CHOBERT rivet-type fasteners!

TECO, Inc., leading airline seat manufacturer, standardizes on Chobert rivets for many sheet metal assembly and miscellaneous fastening requirements. The Chobert High-Speed Riveting System is especially designed for *fully-automatic blind or open riveting* of structural and non-structural assemblies and attaching name plates, identification tags, breather and filter screens, etc.

problem: *To find a faster, easier way to attach upholstery button snaps to tubular seat frame and reduce number of hand operations required by self-tapping screws, nuts, bolts and pins.*

answer: *Fully-automatic "repeater action" Chobert riveter and rivet-fasteners make a complete fastening at the press of a trigger — as shown in the accompanying sequence illustrations — prove to be the complete answer!*



1. Upholstery button snap is placed on Chobert rivet held on flared mandrel in jaw of automatic riveter.
2. Chobert rivet (protruding through button snap hole) is placed in pre-drilled hole in tubular structure.
3. Trigger is pressed and mandrel is pneumatically withdrawn to properly upset Chobert rivet on inside wall of tube making a clean, positive fastening — and next rivet is automatically made ready from riveter's magazine for attaching next unit!

NO SKILLED HELP REQUIRED

The Chobert High-Speed Automatic Riveting System gives top results even with unskilled help. A wide variety of Chobert rivet styles and sizes are available and magazine loading of pneumatic riveter is fast and simple. A single gun can set up to 2000 rivets per hour. Pressing the trigger pneumatically withdraws flared mandrel which forms the rivet "tail" giving a uniform positive grip.

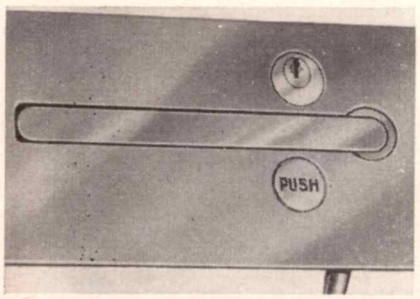
WRITE for complete information today!

chobert **AVIATION DEVELOPMENTS INC.**

210 SOUTH VICTORY BLVD. BURBANK, CALIFORNIA

AVIATION DEVELOPMENTS (CANADA), LTD., TORONTO | AVIATION DEVELOPMENTS, LTD., LONDON, ENGLAND

control current requirement; wide environmental range; miniature size, and light weight. They are designed with a definite neutral position for the friction disc, precluding dragging on the friction face regardless of mounting position. Designed to meet military environmental specifications, the units are made with anodized finish, fungus-inert materials, and encapsulated windings. They are constructed of corrosion resistant materials. Operating temperature range is —65° to +165° F. With the incorporation of a telephone-type relay, maximum response time of all three units is 6 millisec or less; without a relay, response time is slightly higher. They are designed for a maximum torque of 16 oz-in, and for intermittent duty at speeds to 1,000 rpm. Life expectancy is based on a minimum of 200,000 cycles at 30 rpm with load inertia of 1 oz-in. Moment of inertia of input shaft is 0.30 oz-in^2; of output shaft is 0.21 oz-in^2. Input and output gears are designed to customer specifications. Overall length (including shaft) of the largest unit—the double clutch—is only 4.50″. Weights of the three units are: single clutch, 0.8 lbs.; double clutch 1.5 lbs.; clutch brake 1.2 lbs. Electrical requirement is 25v d-c. The units are designed with servo-flange mounting for easy installation.

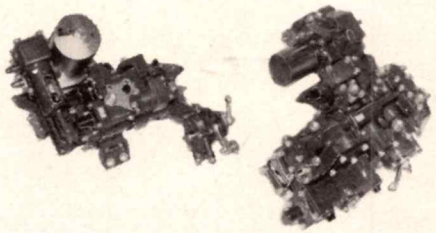


Door Lock

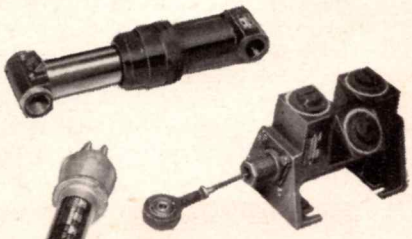
To provide a pressure seal in the exterior door lock of pressurized cabins, Adams-Rite Mfg. Co., Glendale, Calif., has developed a line of locks and handles which can withstand pressures of all high altitude requirements. A typical Adams-Rite pressurized locking handle of flush design developed for military and commercial transports may be locked or unlocked outboard by key. A push button ejects the flush handle. Inboard, a second handle is provided. This lock weighs only 1.6 pounds and is designed to withstand pressures up to 18.5 lb. per sq. in.

XLO
EX-CELL-O for PRECISION

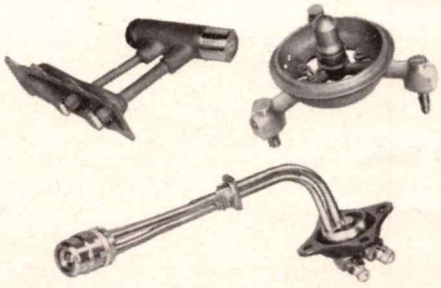
Ex-Cell-O Precision at Production Prices



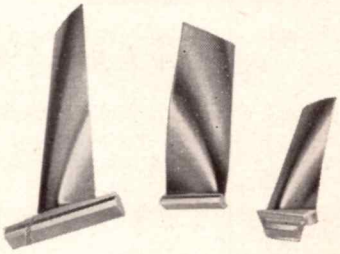
FUEL CONTROL AND METERING ASSEMBLIES



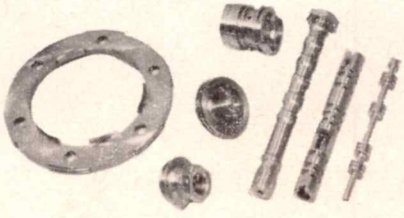
ACTUATOR ASSEMBLIES HYDRAULIC & PNEUMATI



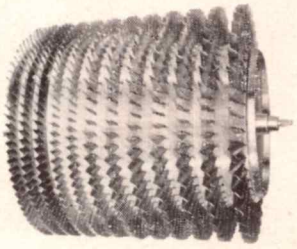
FUEL NOZZLES FOR JET ENGINES



JET ENGINE BLADES



MISCELLANEOUS AIRCRAFT AND COMMERCIAL PRECISION PARTS



JET COMPRESSOR ROTORS

Ex-Cell-O's facilities include laboratory control of materials, design and process engineering, machining of all materials, complete quality control to meet the most rigid specifications, and delivery to meet customers' requirements.

For information or a quotation, write or phone the Precision Product Division of Ex-Cell-O.

54-23

EX-CELL-O CORPORATION • DETROIT 32, MICHIGAN

MANUFACTURERS OF PRECISION MACHINE TOOLS • GRINDING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

what counts is...

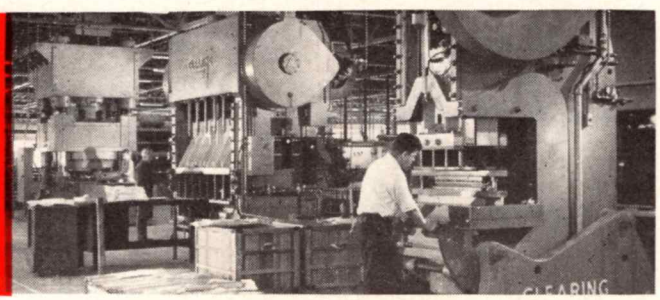
—how good

Devoted exclusively to aircraft production, the recently built Kawneer Aircraft Division plant has been planned for the manufacture of top quality assemblies, sub-assemblies, and detail parts. Your requirements are produced on new, well maintained machines and equipment operated by a labor force averaging 12 years' experience in metalworking. From World War I when Kawneer developed streamlined steel tubing to the present production of complete cockpit enclosures and other assemblies for jet aircraft, Kawneer's reputation for quality has steadily grown.

—how sure

A sound management team, and the economy of well planned production lines plus long experience assure you of delivery when and where you want it. Kawneer maintains constant liaison with its customers. This process enables both Kawneer and customer to be currently informed as to changes and as to engineering and production progress right up to delivery on the scheduled date. Knowledge of industry, production methods, and creative engineering backed by Air Force certified quality control standards mean that you will safely meet your own production schedules.

—how much

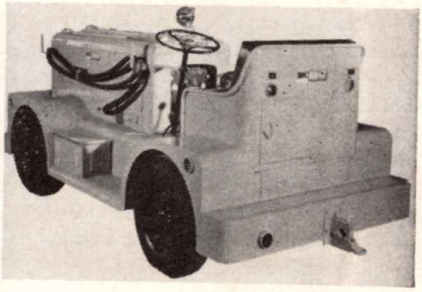


Both plant and equipment have been planned for smooth, economical operation. Flexibility and precision have been "built in" to successfully work as your partner. Integration and production of aircraft products, only, translate themselves into a dependable, money-saving source.

Kawneer
NILES, MICHIGAN
Berkeley, Calif. · Lexington Ky. · Toronto, Can.
AIRCRAFT PRODUCTS DIVISION

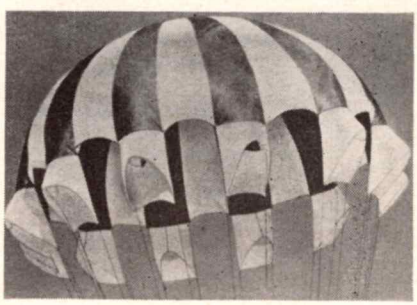
SINCE 1907, FABRICATORS OF METAL AIRCRAFT ASSEMBLIES AND ARCHITECTURAL PRODUCTS.

AVIATION EQUIPMENT



1500 Ampere Ground Power Unit

To meet the demands of larger aircraft for more power while on the ground, a new, rider-type, self-propelled ground power unit has been developed by Motor Generator Corp., Troy, O. The unit is designed for aircraft requiring a power unit of 1500 amperes at 28.5 volts D.C. continuously, or 2000 amperes for three minutes intermittent duty. It is a heavy duty power unit, powered by an industrial engine, providing a constant voltage for checking out electrical systems, as well as for engine starting. The unit answers a dual purpose, functioning as a standard self-propelled vehicle for getting to the plane, then as an auxiliary ground power unit to take over the plane's load while on the ground. Provision is also made for towing aircraft. It can be modified for constant current or current-limiting types of jet engine starting. Special features and controls are included as standard equipment for safety, operating economy, and low maintenance.



Subsonic Parachute

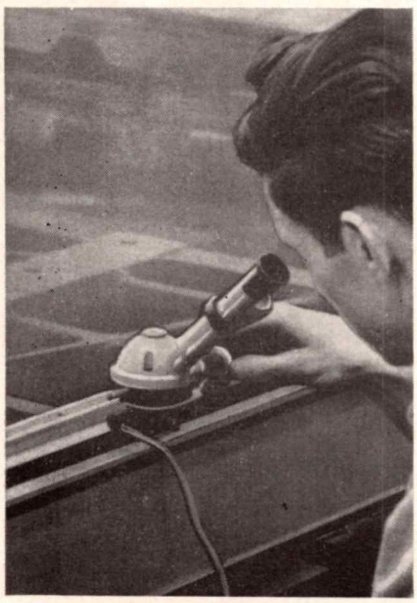
A new type life-saving chute capable of successful recoveries at high subsonic speeds, the "Guide Surface Personnel Parachute," uses revolutionary principles of parachute design to achieve greater stability during descent, a slower rate of descent and reduced opening shock. It is a Pioneer Parachute Company product which, says Lyman H. Ford, company President, represents "a significant step forward in meeting the problem

presented by high aircraft speeds and eliminating the swing or oscillation of standard chutes during descent."

The new chute is so stable that it virtually assures straight-down descent and feet-down landing.

It has been tested by 300 dummy drops and over 700 live jumps up to speeds of 600 mph and at altitudes as low as 2,100 ft., proving it to have the lowest opening shock of all known man-carrying parachutes. Opening shock is especially important to the jumper at high speeds.

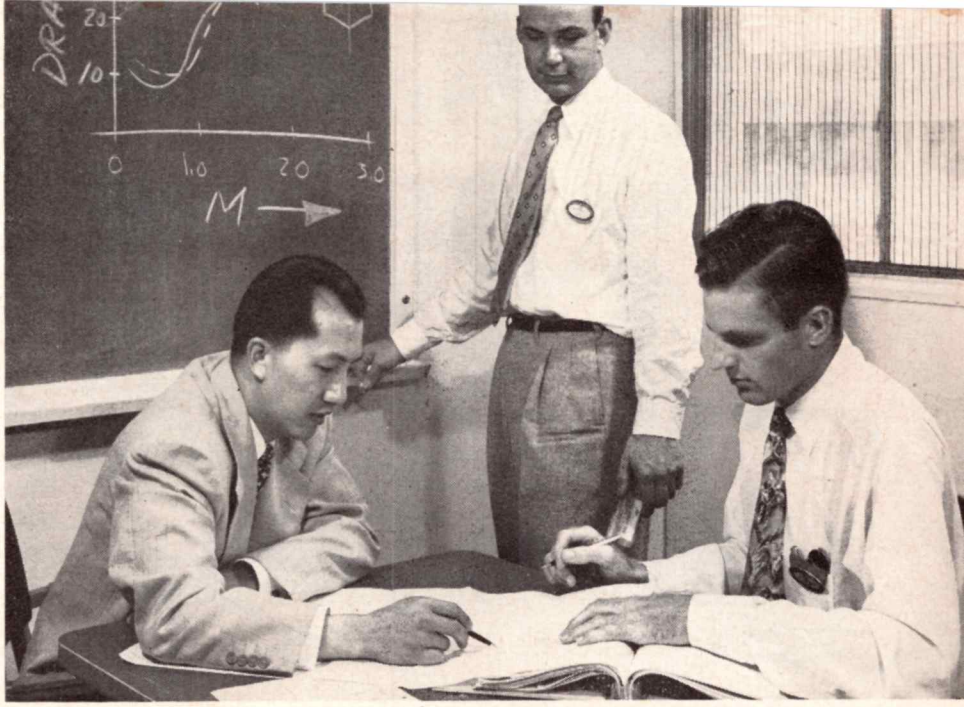
Stability is achieved by a series of guide extensions sewn into the skirt of the canopy. These elliptical-shape flaps are attached at every second gore or triangular panel that goes to form the canopy. During a jump, they form a 45 deg. angle to line of descent and produce a particular air deflection. A high rate of drag is also produced in the open spaces between the extensions without increase in the amount of canopy cloth. This slows down the rate of descent which is thus reduced to 19.6 fps, in contrast with speeds up to 25 fps for conventional chutes.



Optical Straightedge

A beam of light, interrupted by the inscribed reticle of a precision "feeler" microscope, measures deviations as small as .000025" on flat surfaces up to 20 in. long, in the Griswold Huet Optical Straightedge. Previously available only in five- or ten-foot length, the new 20 in. model brings the ease and accuracy of this measuring method to smaller-scale machining or polishing operations.

END



Jim Hong, Aerodynamics Division head, discusses results of high speed wind tunnel research on drag of straight and delta wing plan forms with Richard Heppe, Aerodynamics Department head (standing), and Aerodynamicist Ronald Richmond (seated right).

Lockheed Expands Aerodynamics Staff

With five prototypes already in or near flight test, Lockheed's Aerodynamics Division is expanding its staff to handle greatly increased research and development on future aircraft in commercial and military fields.

The five prototypes, which show the breadth and versatility of Lockheed engineering, are: The XF-104 supersonic air superiority fighter; XFV-1 vertical rising fighter; C-130 U.S.A.F. turbo-prop cargo transport; R7V-2 U.S.N. turbo-prop Super Constellation transport; and an advanced jet trainer of the T-33 type.

New projects now in motion are even more diversified and offer career-minded Aerodynamics Engineers and Aerodynamicists unusual opportunity to: create supersonic inlet designs for flight at extremely high altitude; match human pilots with rapid oscillations of supersonic aircraft at low altitude; develop boundary layer control systems for safe take-off and landing of fighters and transports; remove aileron reversal and tail flutter problems incurred in high speed flight through analysis and design; participate in determining configurations of turbo-prop and jet transports and advanced fighters, interceptors and bombers.

To Aerodynamics men interested in those problems Lockheed offers:

increased salary rates now in effect; generous travel and moving allowances; an opportunity to enjoy Southern California life; and an extremely wide range of employee benefits which add approximately 14% to each engineer's salary in the form of insurance, retirement pension, sick leave with pay, etc.

You are invited to write E. W. Des Lauriers for an application blank and brochure describing life and work at Lockheed.

LOCKHEED AIRCRAFT CORPORATION

BURBANK **CALIFORNIA**

V.S.P.

What do YOU know about the vectored slipstream principle?

If you are one of a select group of men that can offer valuable contributions to its application and effects, why not look into Fairchild's career opportunities?

You probably know that Fairchild is now producing the C-123 *Avitruc*, as well as the world-famous C-119 *Flying Boxcar*. But did you know that reconnaisance aircraft . . . jet fighters . . . and jet bombers and transports are on the drawing boards too? These diversified, stimulating assignments increase the inventive challenge to Fairchild's team of qualified aerodynamicists.

Gracious country living only minutes away from urban Baltimore or Washington . . . paid pension plan . . . an excellent salary with paid vacations . . . an ideal working environment . . . generous health, hospitalization and life insurance . . . and the many other benefits of a progressive company add to the pleasure of working with Fairchild.

You'll be investing wisely in a secure future if you take time today to write to Walter Tydon, Chief Engineer, outlining your qualifications. Your correspondence will be kept in confidence, of course.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Aircraft Division
HAGERSTOWN, MARYLAND

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, MARCH 3, 1933, AND JULY 2, 1946 of AERO DIGEST including Aviation Engineering published monthly at New York, N. Y., for October 1, 1954.

State of New York }
County of New York } ss.:

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Frederic Hamlin, who, having been duly sworn according to law, deposes and says that he is the Publisher of the AERO DIGEST and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforsaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor and business managers are: Editor and Publisher, Frederic Hamlin, 511 Eleventh St., N.W. Washington 4, D. C.; Business Manager, None.

2. That the owner is: The Aeronautical Digest Publishing Corporation, 515 Madison Avenue, New York 22, N. Y.; The Lincoln Press, Inc., 511 Eleventh St., N.W. Washington 4, D. C. James C. Galloway, 816 West Fifth Street, Los Angeles, California.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: None.

4. That the two paragraphs next above giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the persons or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stocks, bonds or other securities than as so stated by him.

(Signed) FREDERIC HAMLIN.

Sworn to and subscribed before me this 22nd day of September, 1954.

(Signed) MICHAEL DIPACE,

Notary Public, of the State of New York, No. 31-0966175
Qualified in New York County.
Commission Expires March 30, 1955.

BUYERS' *Directory*

Rates: $11.00 per column inch, single insertion; $10.00 per column inch, six insertions; $9.00 twelve insertions per year

DYKEM STEEL BLUE®

Stops Losses making Dies and Templates

Popular package 8-oz. can fitted with Bakelite cap holding soft-hair brush for applying right at bench; metal surface ready for layout in a few minutes. The dark blue background makes the scribed lines show up in sharp relief, prevents metal glare. Increases efficiency and accuracy.

Write for sample on company letterhead

THE DYKEM COMPANY
2303B North 11th St. • St. Louis 6, Mo.

WANTED—SURPLUS AIRCRAFT PARTS

or termination inventories.
Get our cash offer by return mail.
Send lists to:
COLLINS ENGINEERING COMPANY
9050 Washington Blvd., Culver City, Calif.

IF YOU CHANGE YOUR ADDRESS — ADVISE US IMMEDIATELY TO ASSURE RECEIPT OF ALL ISSUES

WHY NOT PUT THIS SPACE TO WORK FOR YOU?

Your sales message here will reach the largest buying audience in America among the manufacturers of Aircraft, Missiles, Powerplants and their components.

AERO TRADES
INC.
MACARTHUR AIRPORT
RONKONKOMA, L. I.
EXPERIMENTAL WORK
MODIFICATIONS ENGINEERING
Specialists in Wood & Metal
Manufacturers of Airplane Parts
Upholstering
Airframe Class 1 and Class 3 Limited Airframe
Government Approved Station 115

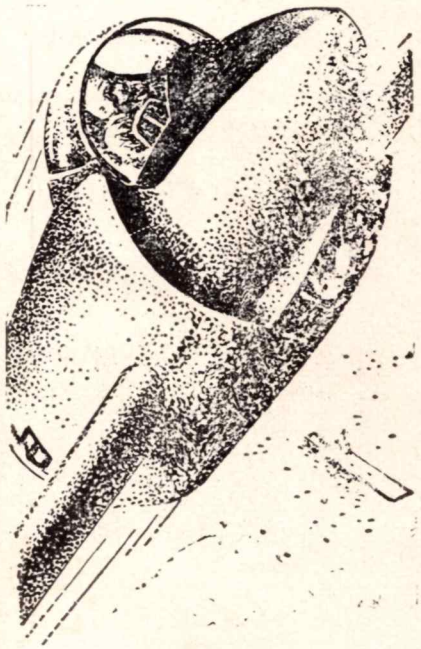
WANTED—SURPLUS ROD & BAR

Stainless — Aluminum — Steel — Brass
Any size; type and quantity. Cash for termination inventories.
Send lists to:
COLLINS ENGINEERING COMPANY
9050 Washington Blvd., Culver City, Calif.

CLASSIFIED ADVERTISEMENTS

AVIATION SUPPLIES

BATORI PRECISION COMPUTER (all metal) Pocket size 4⅝ inches, leather. Case and instructions $15.00; New Practical Manual of E-6B Computer $3.00; Weems Navigation Plotter $2.00; E-6B Computer in Leather case $10.00; Books by CHARLES A. ZWENG lead the field. Examinations included. Rating books average 300 pages each, fully illustrated. Now—Mr. Zweng's newest book, "Helicopter Rating," 340 pages, fully illustrated, prepares for all helicopter ratings $5.00; Meteorology for Airmen, (Zweng) $3.00; Parachute Technician, prepares you for your rating $3.00; Airport Operation and Management by Zweng; DeLuxe $4.50; Aircraft & Engine Mechanic Rating $4.00; Flying the Omnirange $4.00; Airline Pilot Transport rating with examinations only $5.00; "Aeronautical Training," original Quiz System for Private and Commercial Pilots Examination now contains the New Typical Open Book CAA Commercial Pilot Examination, $4.00; Flight Engineer revised Edition $5.00; Ground Instructor Rating with examinations $4.00; Ground Instructor, basic text $4.00; Aircraft Dispatcher $5.00; Flight Engineer Log Books $2.00; Zweng Aviation Dictionary $6.00. (Free catalog.) Pan American Navigation Service, Dept. 12021-24 Ventura Blvd., N. Hollywood, California.



The Demon

ENGINEERS

Needed for assignment in

Airplane
Helicopter
Missile Engineering

AERODYNAMICISTS
STRESS ENGINEERS
DESIGN ENGINEERS
DYNAMICISTS
FLIGHT TEST ENGINEERS
MISSILE ELECTRONICS MEN
THERMODYNAMICISTS
TECHNICAL ILLUSTRATORS

We also have a limited number of positions available for recent college engineering graduates.

Relocation assistance to qualified applicants—good housing available.

Address inquiries to:

Technical Placement Supervisor
Box 516, St. Louis 3, Missouri

McDONNELL *Aircraft Corporation*
ST. LOUIS 3, MO.

ADVERTISERS INDEX

A

A. C. Spark Plug Div. 59
Agency—D. P. Brother & Co.
Adel Divsion—General Metals Corp. 118
Agency—The McCarty Co.
Advance Electric & Relay Co. 12
Agency—Western Adv. Agency Inc.
Aero Digest 86
Aerojet-General Corporation
Div.: General Tire & Rubber Co. . 66
Agency—D'Arcy Advertising Co.
Air Marine Motors 121
Agency—Walter Wiley, Incorporated
Aircraft Transformer Corp. 150
Agency—Malcolm Severance Co.
AiResearch Mfg. Co. 9
Agency—J. Walter Thompson Co.
Airex Rubber Company
Affiliated with Hetrick Mfg. Co. . 138
Agency—Chas. Palm & Co.
Allison Division 16
Agency—Kudner Agency Inc.
American Chain & Cable Co. 57
Agency—Reincke, Meyer & Finn Inc.
American Electric Motors 8
Agency—Clyde D. Graham
American Electrical Heater Co. 122
Agency—F. B. Hubert
American Gyro Corporation 141
Agency—P. W. Voorhees
American Phenolic Corp. 130
Agency—Burton Brown
American Seating Company 128
Agency—Roche, Williams & Cleary Inc.
Aro Equipment Corporation 137
Agency—Beeson-Reichert Inc.
Aviation Developments Inc. 154
Agency—Jaycraft Company
Axelson Manufacturing Co. 123
Agency—C. B. Juneau, Inc.

B

B. H. Aircraft Co. 98
Agency—Harold Marshall
B. H. Instrument Co. 14
Agency—The Kotula Co.
Bendix Aviation Corp.—
Aviation Products 107
Agency—MacManus, John & Adams Inc.
Bendix Aviation Corp.—
Eclipse Pioneer 63
Agency—MacManus, John & Adams Inc.
Bendix Aviation Corp.—
Scintilla Division 15
Agency—MacManus, John & Adams Inc.
Bendix Aviation Corp.—
Pacific Division 85
Agency—The Shaw Co.
Bowers Battery & Spark Plug Co. ... 152
Agency—Beaumont, Heller & Sperling
Briles Manufacturing Co. 129
Agency—Lee Burns

C

California Reinforced Plastics Co. ... 128
Agency—Raymond I. Lang
Challenge Machinery Co. 106
Agency—Illinois Simmonds & Simmonds Inc.
Chance Vought Inc. ..... 2nd Cover
Agency—Lennen & Newell Inc.
Chandeysson Electric Co. 77
Agency—Oakleigh R. French & Assoc.
Com Air Products Inc. 95
Agency—Phil D. McHugh Co.
Consolidated Diesel Electric Corp. ... 109
Agency—Woodward & Byron Inc.
Consolidated Vultee Aircraft Corp.
Front Cover
Agency—Buchanan & Co. Inc.
Continental Motors 148
Agency—The Hopkins Agency
Cook Electric Company 125
Agency—Glenn-Jordan-Stoetzel Inc.
Cornelius Company, The 146
Agency—Dwyer & Devoe
Crane Packing Co. 136
Agency—Symonds, MacKenzie & Co.
Crosley Division—Avco Mfg. Corp. .. 75
Agency—Ralph H. Jones Co.

D

Delron Company, Inc., The 132
Agency—Abbott Kimball Company
Douglas Aircraft Co., Inc. 115
Agency—J. Walter Thompson Co.
Dynamic Air Engineering Inc. 142
Agency—The McCarty Co.

E

Electrical Engineering & Mfg. Co. ... 101
Agency—West-Marquis Inc.
Ex-Cell-O Corporation 155
Agency—Holden-Chapin-Larue, Inc.

F

Fairchild Engine & Airplane Corp. 150 & 158
Agency—Gaynor & Company Inc.
Fletcher Aviation Corp. 135
Agency—Hixson & Jorgensen, Inc.
Foote Bros. Gear & Machine Corp.
4th Cover
Agency—Waldie & Briggs Inc.
Ford Instrument Co. 106
Agency—G. M. Basford Co.

G

General Testing Laboratories 152
Div. Electronic Mfg. Corp.
Gladden Products Corp. 92
Agency—Walter C. Davison Co.
Goodyear Aviation Products Div. 2
Agency—Kudner Agency Inc.
Gorn Electric Co. Inc. 110
Greer Hydraulics 124
Agency—Dunwoodie

H

Hartwell Aviation Supply Co. 140
Agency—The McCarty Co.
Harvey Aluminum 111
Agency—Hixson & Jorgensen Inc.
Haydon Mfg. Co., Inc. 100
Agency—Hugh H. Graham & Assoc. Inc.
Heinemann Electric Co. 89
Agency—Thomas R. Sundheim
Hexcel Products Co. 128
Agency—Raymond I. Lang
Hufford Machine Works Inc. ....3rd Cover
Agency—Clyde D. Graham
Hycon Manufacturing Co. 144
Agency—Hixson & Jorgensen

J

Jack & Heintz Inc. .....18 & 19
Agency—Fuller & Smith & Ross, Inc.

K

Kato Engineering Co. 152
Agency—Frizzell Advertising Agency Inc.
Kawneer Company, The 156
Agency—Fuller & Smith & Ross Inc.
Keller Tool Company .....96 & 97
Agency—The Fensholt Adv. Agency
Kollsman Instrument Corp. 149
Agency—Schaefer & Favre

L

Lavelle Aircraft Corp., Inc. 153
Agency—R.G.E. Ullman Organization Inc.
Leach Relay Co. 114
Agency—The McCarty Co.
Lear Inc. .....60 & 61
Agency—Buchanan & Co.
Liquidometer Corp., The 139
Lockwood Aircraft Corp. .....112 & 113
Agency—Foote, Cone & Belding
Lockwood Aircraft Corp. 157
Agency—Hal Stebbins Inc.

M

Martin Company, The Glenn L. 119
Agency—Van Sant Dugdale & Co.
Micron Gear Mfg. Co. 150
Agency—Arthur A. Judson Inc.

N

New York Air Brake Co., The 69
Agency—Humbert & Jones
Northrop Aircraft Inc. 145
Agency—Wes-Marquis Inc.
Nutt-Shel Co. 116
Agency—Welsh, Hollander & Coleman

O

Oster Manufacturing Co., John 151
Agency—Henri, Hurst & McDonald Inc.

P

Pacific Scientific Co. 4
Agency—Klitten Co., Inc., Martin R.
Pastushim Aviation Corp. 143
Agency—Lynn-Western Inc.
Pesco Products—
Div. Borg Warner Corp. 87
Agency—Jayme Organization, Inc., The
Pioneer Parachute Co. 161
Agency—Julian Gross

R

Radio Corp. of America 144
Agency—Al Paul Lefton Co. Inc.
Radio Receptor Co., Inc. 120
Agency—Walter J. Zimmerman Assoc.
Rahm Instruments Inc. 150
Agency—Herbert W. Cohon Co.
Randolph Products Co. 142
Agency—Town Advertising Assoc.
Rheem Manufacturing Co. .....70 & 71
Agency—Campbell-Ewald Co.
Roe, Canada Limited, A. V. 73
Agency—Cockfield, Brown & Co.
Rohr Aircraft Corp. 127
Agency—Barnes Chase Co.

S

Saginaw Steering Gear Div. .....82 & 83
Agency—Price, Tanner & Willox Inc.
Sargent Engineering Corp. 91
Agency—Darwin H. Clark Co.
Servo Corp. of America 152
Agency—Michel-Cather Inc.
Southwest Products Co. 108
Agency—O. K. Fagan
Sperry Gyroscope Company 20
Agency—Reach, Yates & Mattoon Inc.
Steel Products Engineering Co. 133
Agency—Geyer Advertising Inc.
Stokvis-Edera & Co., Inc. 152
Agency—The Lampert Co.
Stroukoff Aircraft Corporation 110
Summers Gyroscope Co. 13
Agency—Byron H. Brown & Staff
Swedlow Plastics Company 6
Agency—Francis D. Gonda Co.

T

Teleflex, Inc. 7
Agency—John T. Hall & Co.
Temco Aircraft Corp. 162
Agency—Taylor-Norsworthy Inc.
Tenney Engineering Inc. 134
Agency—O. S. Tyson & Co.
Terry Co., George A. 142
Timken Roller Bearing Co., The 79
Agency—Batten, Barton, Durstine & Osborn

U

United Aircraft Corporation—
Sikorsky Division .....10 & 11
Agency—Lennen & Newell Inc.
United Aircraft Products, Inc. 105
United Manufacturing Co. 104
Agency—Langeler Adv. Agency Inc.
United States Radium Corp. 90
Agency—Lethen Advertising
Universal Metal Products Co. 102
Agency—Byron H. Brown & Staff

V

Valcor Engineering Corp. 103
Agency—Adolf F. Gottesman
Verson AllSteel Press Co. 147
Agency—Russell T. Gray Inc.
Vickers Incorporated 17
Agency—Witte & Burden
Voi Shan Mfg. Co. 117
Agency—Willard C. Gregory & Co.

W

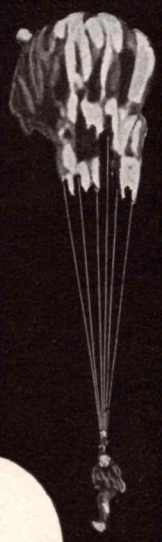
Warner Division—
Detroit Harvester Co. 126
Agency—Clark & Roberts Inc.
Weber Aircraft Corporation 99
Agency—Ruthrauff & Ryan Inc.
Wiggins Oil Tool Co. 1
Agency—Anderson-McConnell
Wilding Picture Productions Inc. 154
Wolfe Company, Franklin C. 65
Agency—Lester Company
Wyman Gordon Company 131
Agency—John W. Odlin Co., Inc.

Z

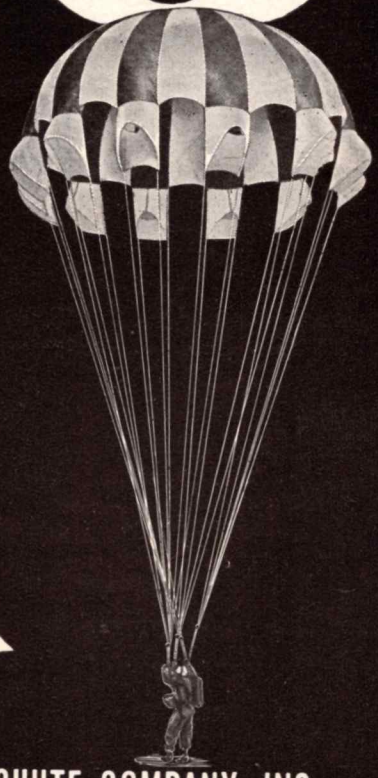
Zenith Plastics Company 93
Agency—Francis D. Gonda Co.

HUGHES PRINTING CO.
EAST STROUDSBURG, PA.

PIONEER guide surface personnel parachutes* make the difference . . .



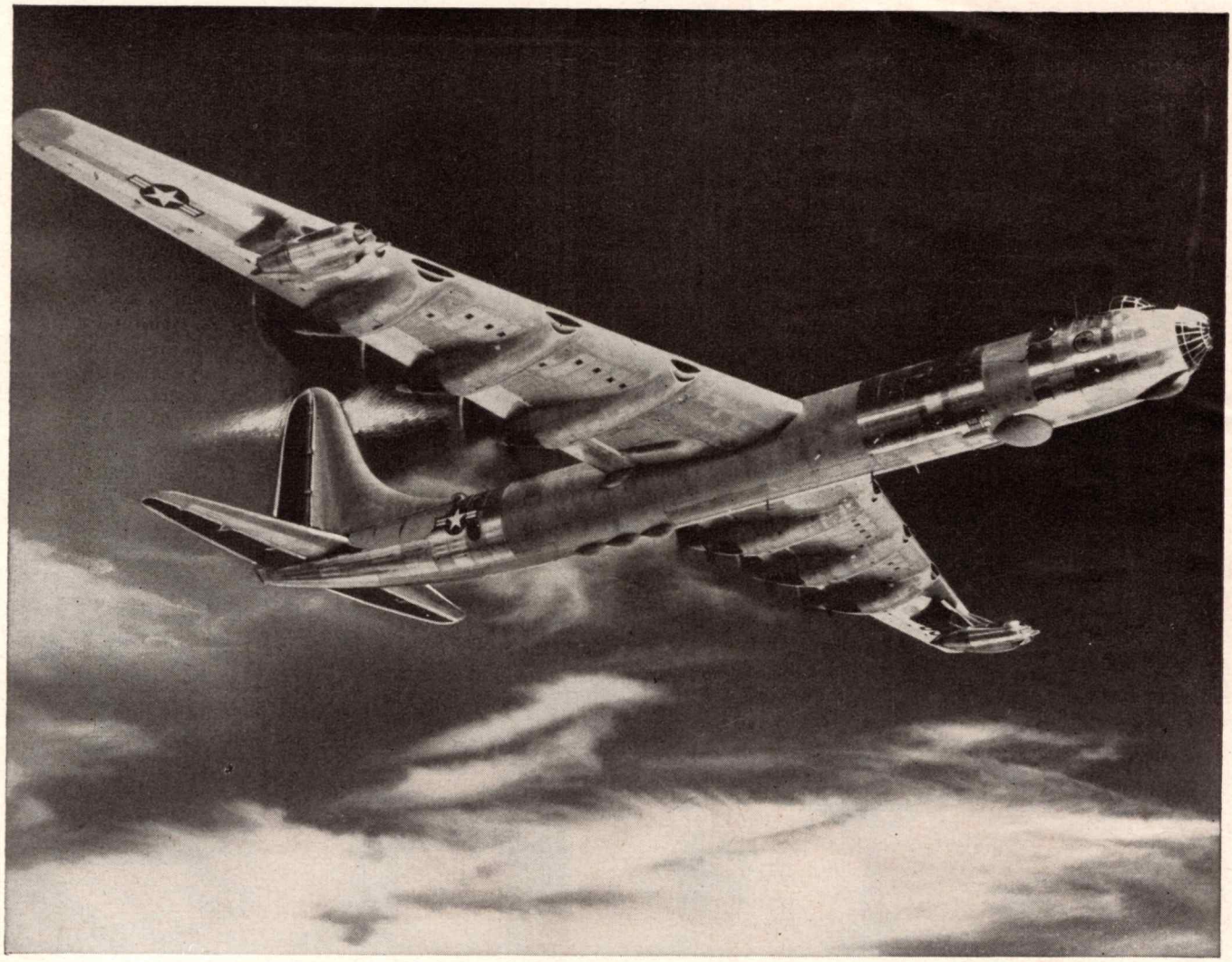
safe



Under the most trying conditions of jet-speed operation at altitudes from record heights to only 200 feet above the earth, the Pioneer P7-B* and P9-B* Guide Surface Personnel Parachutes have delivered positive performance. The Guide Surface principle, commercially exclusive with Pioneer Parachute Company, lessens opening shock, eliminates oscillation and side glide, gives greater stability by retaining a vertical position in the air enabling the airman to land on his feet.

Patents applied for in U. S. and principal countries throughout the world.

PIONEER PARACHUTE COMPANY, INC.
MANCHESTER, CONNECTICUT, U. S. A.
Cable Address, PIPAR

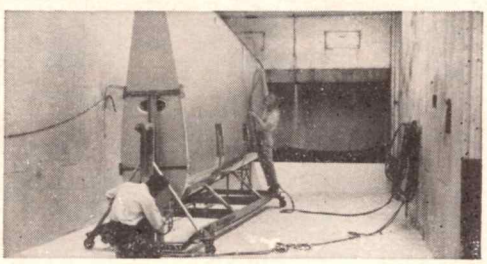


The plane that prevented a war

and TEMCO'S part in building it!

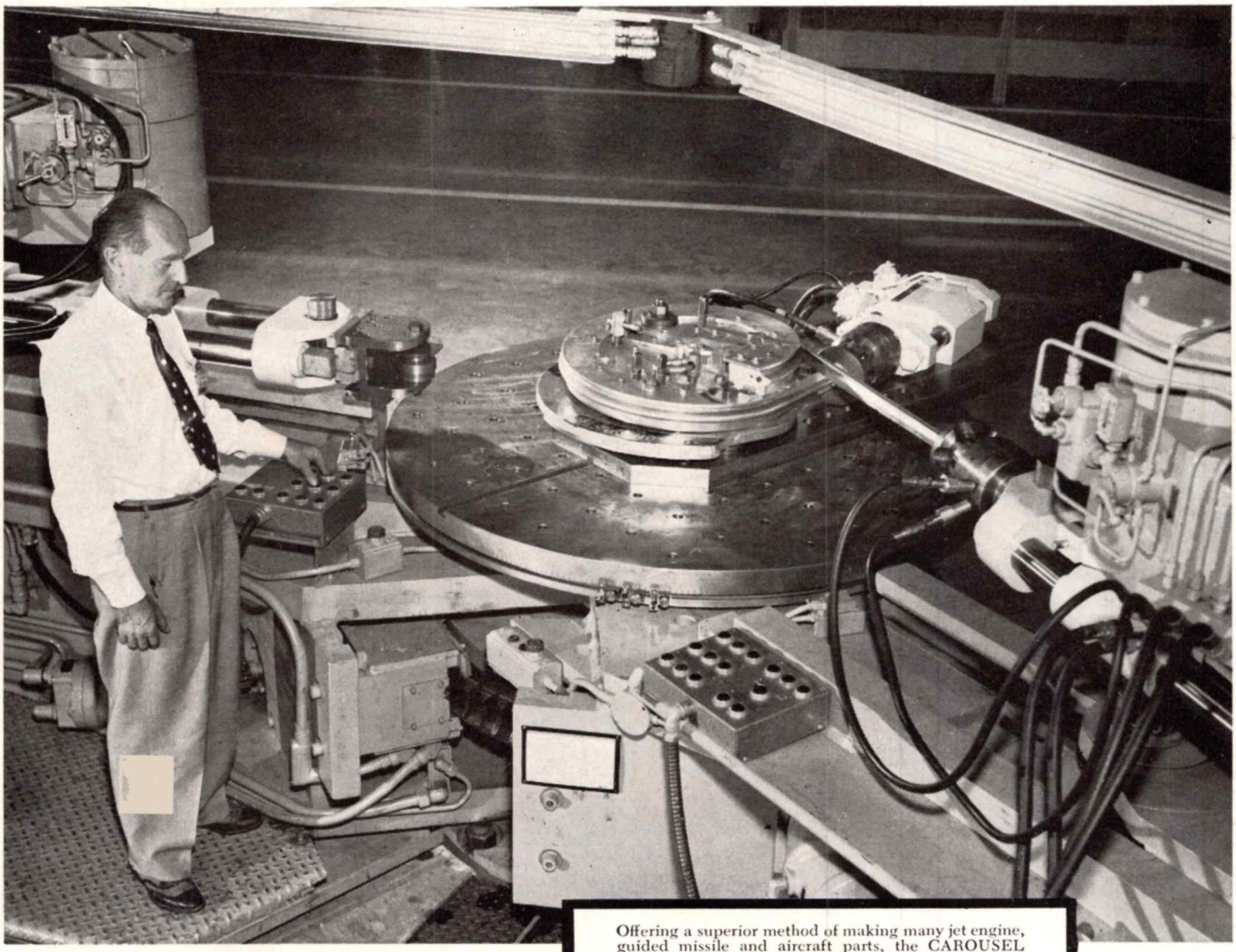
Convair's B-36's and the men of SAC were about all that stood between this country and its enemies in the late 1940's and early 1950's. Many feel that this team prevented a third World War. Today, as then, they are powerful deterents to any would be aggressor. Production of those giant planes required thousands of man hours and involved many problems. Convair helped simplify production by sub-contracting elevator, rudder, and door assemblies to TEMCO.

This is but one of many jobs wherein TEMCO has helped speed the Nation's defense effort. And it is one of the many jobs that has earned TEMCO the reputation for delivering a quality product, on schedule, at one of the lowest costs in the industry.



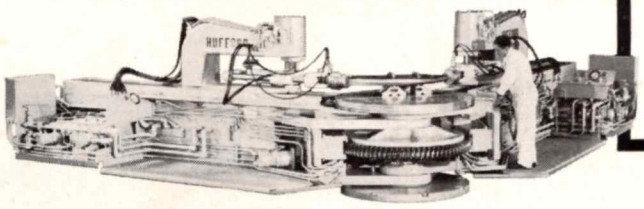
Giant B-36 elevator dwarfs TEMCO workers as it is wheeled into wet spray booth for its last coat of paint before being shipped to Convair, Ft. Worth, for final assembly.

TEMCO
AIRCRAFT CORPORATION
DALLAS, TEXAS



Offering a superior method of making many jet engine, guided missile and aircraft parts, the CAROUSEL here forms a full circle. Note the stationary table cylinder grips and stretches from one end, while a rotating arm stretches and wraps from the other. The remaining rotating arm is tooled for simultaneously rolling while stretch-wrap forming.

Photo courtesy Douglas Aircraft Co., El Segundo Division (Calif.)



How many ways can you lick tough forming jobs?

Hufford again meets forming problems of the aircraft industry by combining several forming methods in one machine!

The new Hufford CAROUSEL greatly expands forming possibilities . . . in method used and range of contours produced. It handles all structural shapes as well as sheets up to 22" wide, and can be furnished in several sizes and tonnage capacities.

Before buying *any* forming equipment ask how the Hufford CAROUSEL solves both simple and complex forming problems, eliminates costly hand-forming and reduces forming costs!

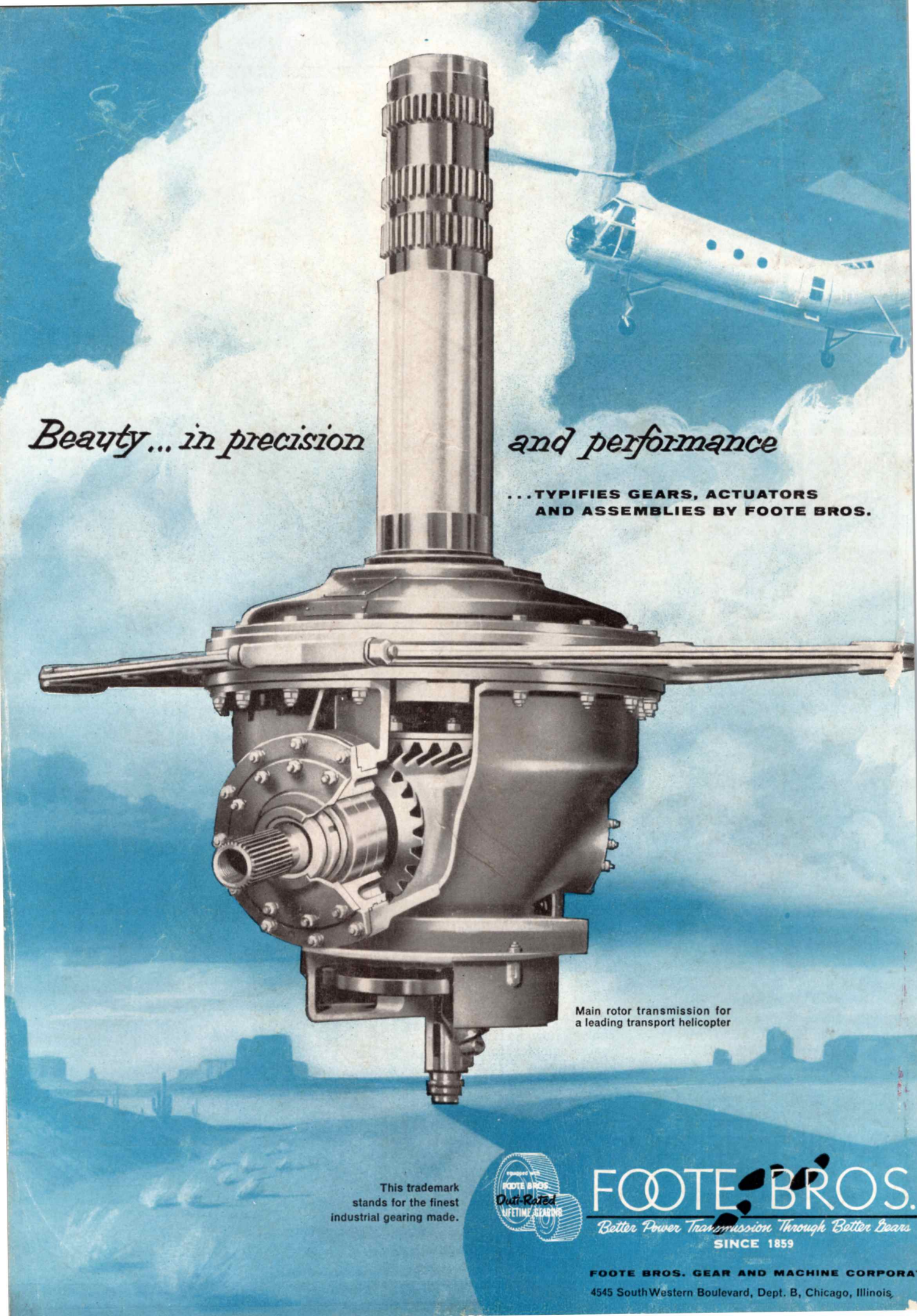
THE HUFFORD
CAROUSEL

provides a *choice* of forming techniques!

- STRETCH-WRAP FORMS
- ROLL FORMS
- WIPE FORMS
- JOGGLES
- BULLDOZES
- STRETCH-LEVELS

HUFFORD
Machine Works Inc.
EL SEGUNDO, CALIFORNIA

Manufacturers of
PRECISION HYDRAULIC STRAIGHTENING PRESSES
PORTABLE HYDRAULIC ELEVATORS • HYDRAULIC STRETCH-LEVELING TABLES
HYDRAULIC STRETCH-WRAP FORMING MACHINES
HYDRAULIC METAL FORMING BULLDOZERS • HYDRAULIC COMPACTION PRESSES
CUSTOM-MADE HYDRAULIC MACHINE TOOLS AND ACCESSORIES


Beauty... in precision
and performance
...TYPIFIES GEARS, ACTUATORS
AND ASSEMBLIES BY FOOTE BROS.
Main rotor transmission for
a leading transport helicopter
This trademark
stands for the finest
industrial gearing made.
FOOTE BROS.
Better Power Transmission Through Better Gears
SINCE 1859
FOOTE BROS. GEAR AND MACHINE CORPORA
4545 South Western Boulevard, Dept. B, Chicago, Illinois